ANGLIA RUSKIN UNIVERSITY

FACULTY OF HEALTH, SOCIAL CARE AND EDUCATION

DIGITAL COMPETENCE IN HEALTH EDUCATION (DCiHE): A TRANSFERRABLE FRAMEWORK FOR CURRICULUM DEVELOPMENT

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'*We are what we repeatedly do. Excellence, then, is not an act, but a habit*'

Will Durant

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ABSTRACT

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DOCTOR OF EDUCATION

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Digital Literacy (DL) is a key-enabler for citizens to fully participate in society, life-long learning for personal or professional reasons, and employability. For healthcare, it is a required foundation factor to deliver the NHS 2020 digital transformation agenda and beyond. Therefore, educational institutions have a duty to ensure that learners graduate with the digital skills necessary to succeed. This work-based research investigated how DL could be conceptualised in the healthcare curricula, and subsequently how tools/processes for embedding it in various programmes could be developed. The research was carried out from a pragmatist perspective as a series of case studies employing an interactive, mixed-methods design.

Initially, the EU DigComp DL framework was investigated for its suitability to classify and quantify the DL of students and staff. Informed by the framework, a series of activity-based learning designs were used to embed digital literacy in the curriculum and explore the tools/processes created for its embedding. Drawing on the findings of the exploratory phase of the investigation, the tools were updated, refined and re-evaluated. Finally, curriculum-design models, processes and tools to support embedding DL into courses were created with the aim at enhancing local practice and, due to their creation and the consequent study of the relative findings, it can be supported that the DigComp framework could be developed as a tool suitable to describe and quantify the digital characteristics of learners and teachers.

The proposed design approach identified the necessary elements for embedding DL in the curriculum. The developed tools/processes, based on the DigComp framework approach, enable the establishment of metrics of digital literacy, and evaluate learner engagement and attainment.

Key words: digital literacy, DigComp, curriculum development, learning design, learning analytics, health care medical education

List of Relevant Peer-reviewed Publications

Year	Publications
2016	Biggins, D., Holley, D., Evangelinos, G. and Zezulkova, M., 2016. Digital Competence and Capability Frameworks in the Context of Learning, Self-Development and HE Pedagogy. In: G. Vincenti, A. Bucciero, M. Helfert and M. Glowatz, eds., *E-Learning, E-Education, and Online-Training (ELEOT) Third International Conference*. Dublin, Ireland: Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, pp.46–53.
2016	Evangelinos, G., Holley, D. and Kerrigan, M.J.P., 2016. Implementing a Model and Processes for Mapping Digital Literacy in the Curriculum (Online Badges). In: A. Moreira Teixeira, A. Szűcs and I. Mázár, eds., *Re-Imaging Learning Environments Proceedings of the European Distance and E-Learning Network 2016 Annual Conference Budapest, 14-17 June, 2016*. Budapest: European Distance and E-Learning Network (EDEN), pp.545–553.
2016	Evangelinos, G. and Holley, D., 2016. Investigating the Digital Literacy Needs of Healthcare Students: Using Mobile Tablet Devices for the Assessment of Student-nurse Competency in Clinical Practice. In: *E-Learning, E-Education, and Online-Training (ELEOT) Second International Conference*. Novedrate (Como), Italy: Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, Springer International Publishing, pp.60–67.
2016	Evangelinos, G. and Holley, D., 2016. Investigating the Digital Literacy Needs of Healthcare Students when using Mobile Tablet Devices. *EAI Endorsed Transactions on e-Learning*, 16(10), p.e8.
2015	Evangelinos, G. and Holley, D., 2015. Embedding Digital Competences in the Curriculum: A Case Study on Student-Experience of an Online Technology-enhanced, Activity-based Learning Design. In: A.M. Teixeira, A. Szűcs and I. Mázár, eds., *Expanding Learning Scenarios. Opening Out the Educational Landscape*. Barcelona, Spain: European Distance and E-Learning Network (EDEN), pp.805–813.
2015	Evangelinos, G. and Holley, D., 2015. A Qualitative Exploration of the DIGCOMP Digital Competence Framework: Attitudes of students, academics and administrative staff in the health faculty of a UK HEI. *EAI Endorsed Transactions on e-Learning*, 2(6), p.e1.
2014	Evangelinos, G. and Holley, D., 2014. Developing a Digital Competence Self-Assessment Toolkit for Nursing Students. In: A.M. Teixeira, A. Szűcs and I. Mázár, eds., *E-Learning at Work and the Workplace. From Education to Employment and Meaningful Work with ICT E-learning at Work and the Workplace.* Zagreb, Croatia: European Distance and E-Learning Network (EDEN), pp.206–212.
2014	Evangelinos, G. and Holley, D., 2014. A Qualitative Exploration of the EU Digital Competence (DIGCOMP) Framework: A Case Study Within Healthcare Education. In: G. Vincenti, A. Bucciero and C. Vaz de Carvalho, eds., *E-Learning, E-Education, and Online-Training (ELEOT) First International Conference*, Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering. Cham: Springer International Publishing, pp.85–92.

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Chapter 1. Introduction

1.1 Digital Literacy in Higher Education

At the advent of the 21st Century digital participation was limited to using computers and having access to the world-wide web for work and learning (Bawden, 2001). The socio-economic impact of the differences of opportunities for accessing information through Information and Communication Technologies (ICTs) and to the Internet raised interesting questions on how to develop inclusive digital societies (Organisation for Economic Co-operation and Development (OECD), 2001; Livingstone, van Couvering and Thumim, 2005; Deursen, 2010). To address these issues attempts were made so as the formal educational system to provide access to ICTs and the Internet (McConnaughey and Lader, 1998; Irving et al., 1999). Hargittai (2002, p.1) warned about the importance of differentiating user competence in their '*…ability to efficiently and effectively find information on the Web*' from plain access, shifting the focus from access to active participation. Classifications started focusing on knowledge and skills and it became apparent that a new set of digital conceptualisations were to emerge (Molnár, 2003) based on the understanding of multiple degrees of digital participation far exceeding plain access (Livingstone and Helsper, 2007). Van Dijk (2006, p.228) described this concept in terms of '*digital skills*', that could be elaborated by '*information skills*' used to manage information in the digital domain, and '*strategic skills*' described as '*…capacities to use computer and network sources…*' for accomplishing specific goals.

With digital-technology development and its role becoming prominent in multiple aspects of our lives, the usage patterns changed to include personal and leisure activities. The competences required were initially perceived as specific technical skills and knowledge focusing on access, but at a later time they were expanded to include the efficient and analytical use of digital technology in globalised environments (Cattaneo et al., 2009). Erstad (2010) supported that digital inclusion – constituted by knowledge and skills – was dependent on competence and access, and that use only was not sufficient. In a study on Internet-usage skills among the Dutch population Van Deursen and van Dijk (2010) found that, although basic operational Internet skills were measured as high, information organisation and strategic skills were lacking. Access to digital technology and exposure to the Internet did not readily result in competence in the digital domain. Over time, the focus shifted from mere ability to using digital technologies to their productive and efficient use. Examining the external environment at a time closer to the present and in the immediate geographical environment, it was observed that digital technology access and use are still topics pertinent to contemporary societies.

In 2016 79% of European citizens accessed the internet weekly, while 71% of them had access on a daily basis. However, only 63% of people belonging to disadvantaged groups (e.g. elderly, low/no education, low income) accessed the Internet weekly (Eurostat, 2016). From the employability perspective, 37% of the EU workforce were lacking in sufficient digital skills with 11% having no digital skills at all (European Commission, 2017a). The European Skills and Jobs survey found that in the EU, 7 out of 10 jobs required at least basic competency in using digital technologies (European Centre for the Development of Vocational Training (CEDEFOP), 2016). A significant proportion (28%) of European internet users do not possess the advanced digital skills required by the labour market (European Commission, 2017a). Advanced skills in a variety of digital applications and the related transversal skills are increasingly becoming a requirement for access to jobs (Berger and Frey, 2016). The demand for digital competency in the workplace is increasing: 90% of professional roles, and 98% of managerial, require at least basic digital skills (Curtarelli, Gualtieri, Jannati and Donlevy, 2017). Digital literacy is becoming a necessary requirement for the development of inclusive and democratic labour markets within an increasingly globalised digital environment (Organisation for Economic Co-operation and Development (OECD), 2015). In response to these evolving global trends the European Union established Digital Competence as the most transferable competence (Balcar et al., 2011) out of eight key-competences for continuous, life-long learning (Figel', 2007).

Following a similar pattern the global health environment has changed due to the affordances of digital technology and the Internet that gradually increased access to health information (Brodie et al., 2000; Stiglitz, 2003; Wyatt, Henwood, Hart and Smith, 2005; Glaser, 2007; Abbott and Coenen, 2008; Klecun, 2010; Webster, 2013; Jackson, 2016). Digital technologies were increasingly used for administration, medical diagnostics and interventions. In the UK, although the digitisation of health happened at a slower than the anticipated pace (Limb, 2012), there was a clear steer for the strategic transformation of health services driven by relevant government legislation (UK Government, 2012, 2014) and policy (Department of Health, 2012; UK Government, 2013; House of Lords, 2015).

Recognising the potential of digital technology to improve health services (Academy of Medical Royal Colleges, 2013) the Personalised Health and Care 2020 plan (NHS England, 2014; National Information Board, 2014) was put in motion in an attempt to transform healthcare practice.

While there were encouraging signs that health-related technology adoption was growing, this was mostly due to implementations of electronic clinical records (Ecorys UK, 2016). The digital capabilities and attitudes of the front-line healthcare staff were found to be variable by the Widening Digital Participation Programme evaluation (NHS England, 2015). Developing the digital capabilities of the workforce is fundamental for delivering excellent care, innovating, improving health outcomes (NHS Improvement, 2014), enhancing efficiency, and a key enabler for personal and professional development (Imison, Castle-Clarke, Watson and Edwards, 2016). The Wachter review established a number of principles and recommendations concluding that the secondary care sector could be successfully digitised (Department of Health, 2016) despite the apparent failure of its predecessor National Programme for IT (NPfIT) in NHS (Campion-Awwad, Hayton, Smith and Vuaran, 2014). The people-centred vision for the transformation of health services leverages technological innovations as an intrinsic part of service improvement (Academy of Medical Royal Colleges, 2017) and requires significant up-skilling of the workforce (Honeyman, Dunn and Mckenna, 2016).

When this thesis research commenced, most of the initiatives mentioned above did not exist. According to the The Queen's Nursing Institute (2014) there were 1.4 million professional health carers in the NHS in the United Kingdom and, in order to deliver the digital transformation agenda, it was imperative to develop their digital literacies (Nursing and Midwifery Council, 2010). Exploration of the readiness of nurses to utilise digital technologies in healthcare showed that eight out of ten of the participants were confident or very confident in using technologies. However, the analysis was inconclusive at establishing correlations among training, confidence and digital capability (Renaud and Goucher, 2012). A number of barriers to digital-literacy development were identified: access to technology, low tele-health awareness, and low data security literacy. Studies have also examined nurses' self-assessed computer, nursing-informatics skills (Hwang and Park, 2011; Rajalahti, Heinonen and Saranto, 2014) and self-assessed computing skills (Campbell and Mcdowell, 2011). Two of the studies reported that the participants were lacking basic skills.

Hwang and Park (2011) identified a link between the level of basic skills and nursing-informatics capability, corroborated through evidence by Rajalahti, Heinonen and Saranto (2014), but these studies are not directly comparable due to semantic diffences. Campbell and Mcdowell (2011) found a correlation between higher educational attainment and higher levels of self-reported computing skills. The research in this thesis was conducted with student-nurses, student-midwives and healthcare academics, and the results are broadly coherent with the findings of these studies (Evangelinos and Holley, 2014b, 2015b). Specifically, a high-level of digital literacy was self-reported alongside a seemingly strong, negative correlation with the data-security literacy.

During the time this research was being carried out, the healthcare environment changed significantly and digital technology was increasingly been embedded in clinical and non-clinical settings. Digital literacy became a requirement for managers, doctors, nurses and other health professionals. In health professional education the main driver to develop the digital literacy of the workforce is the Personalised Health and Care 2020 plan (NHS England, 2014; National Information Board, 2014) supported by training (Department of Health, 2011) and other professional development (NHS England, 2016). Alongside the shifting requirements of the workplace, conceptualisations on what constitutes digital literacy evolved and a question on its potential, specific attributes in a healthcare education environment naturally arose during the early parts of this research.

Reflecting on the evolution of the digital-literacy conceptualisations eventually shifted from describing digital literacy narrowly as specific skills, and moved towards more flexible definitions describing general competencies, traits or behaviours. This conceptual shift was difficult to explore within a process-driven, working/learning environment with a highly-developed compliance culture (eICE, 2012). However, as health education providers have a duty to ensure that students are fit for practice in increasingly digitised workplaces, it was decided that the research should be carried within the context of pre-registration, healthcare education. Learners should develop their digital skills not only to complete their studies, but also to become successful in their future employments (Organisation for Economic Co-operation and Development (OECD), 2015; Berger and Frey, 2016; European Centre for the Development of Vocational Training (CEDEFOP), 2016).

In the United Kingdom, the ambition to enhance the digital capability of the workforce and of the population in general, has been articulated in numerous occasions by a variety of key stakeholders. Examples within the higher education sector include initiatives such as the Developing Digital Literacies programme (Joint Information Systems Committee, 2013), the Digital Literacies in the Disciplines programme (Higher Education Academy, 2014) and the Changing the Learning Landscape programme (The Leadership Foundation for Higher Education, 2014). The main drivers for enhancing the digital capabilities of a diverse student population have been identified as a requirement by employers, as well as by professional bodies, an issue which was also reflected in the government and funding council's strategies and policies. As a result the Quality Assurance Agency (QAA) in their Higher Education 2015-16 Review have identified digital literacy as one of the two areas of interest alongside employability (Quality Assurance Agency, 2014). Recently a report from the House of Commons - Science and Technology Committee (2016) warned that *'... almost 90% of new jobs require digital skills to some degree, with 72% of employers stating that they are unwilling to interview candidates who do not have basic IT skills.'* It has become apparent that technological developments, and especially disruptive technologies, have changed the landscape of how people interact with technologies.

At a local level, for a professional practitioner and researcher in a higher education institution in the UK, the findings of the Developing Digital Literacies programme (Joint Information Systems Committee, 2013) were particularly relevant and influential. The programme promoted the development of digital literacies across a number of higher and further education institutions in the UK. The participating institutions adopted a variety of approaches according to their own aims and strategic objectives. The findings of the synthesis report determined the high-level areas, and lessons were learnt for developing digital literacies in practice across a mixture of diverge types of institutions within the UK higher education sector (Beetham, 2014). Having established the challenges that had to be addressed, it became apparent that an effective process and operational model were required for the development of digital literacies of staff and students.

The research presented in this thesis explored the development of student and staff digital literacy in a higher education institution in the United Kingdom. A unique perspective was gained when working with faculty and supporting their learning-technology developmental needs as a professional practitioner. The main challenges in developing the digital capabilities of staff, identified from experience but also documented in the literature, were: (i) lack of structured models for developing and employing new and innovative digital approaches to teaching (and learning), (ii) resistance to change, (iii) failure to utilising the opportunities of informal learning (and teaching) and (iv) difficulties in capitalising the affordances of technology for formative assessment (New Media Consortium, 2013; European Commission, 2014b; Johnson, Adams-Becker, Estrada and Freeman, 2015). In order to address these challenges a fresh approach was needed.

The institutional provision of relevant professional development for academics focused on delivering the digital skills needed to successfully use a variety of technological systems, including student administration software used for data management and learning, teaching and assessment platforms used to enhance the student experience by making the students' access to information easier for the purpose of structuring their learning (e.g. virtual learning environment, electronic assessment, other student information platforms). Within the faculty a variety of developmental methods were employed, including the delivery of pedagogic-development workshops, technical training and hybrid sessions that mixed technology-enhanced pedagogic models and technology inductions. The training programmes were consistently evaluated as good and often resulted in the making of further enquiries by the participants on how they could enrich their teaching by utilising a variety of pedagogies mediated through the creation of technologically-enhanced learning opportunities. Undoubtedly, there was significant progress in utilising new technologies driven by institutional policy, with the majority of academics embracing the strategic vision for adopting technologies and enhancing the student experience. However, only a small percentage of the academics started innovating and enriching their teaching with technological interventions. This raised some interesting questions on how the faculty organisational policies, processes and support mechanisms, could be optimised to encourage innovation and maximise the impact.

This thesis documents the journey of embedding digital literacies in the curriculum by designing learning activities that develop the learner's digital literacy as a by-product of technology-mediated learning relevant to the healthcare discipline. Following developmental iterations, research-informed, evidence-based models, processes and tools have been produced aiming to implement this curriculum-design approach into local practice. Due to the inherent complexities of conducting work-based research as a professional practitioner aiming to change local practice in an ever evolving higher education institution, the research was conducted from a pragmatist perspective, as a series of nested case studies utilising an interactive, mixed-methods design, in three distinct but related phases (see: Figure 8). The overall approach and design models were informed by the relevant technological-pedagogical, digital-literacy literature and the relevant processes and tools have been evaluated in the context of local practice during the exploratory and enhancement stages of the research, phases one (P1) and two (P2) respectively (see: Figure 9).

Phase one (P1), explored the potential and limits of utilising the EU DigComp framework and a systematic approach, in an attempt to address Research Questions 1 and 2 (RQ1&2), and support the development of digital literacy in healthcare education. During phase two (P2), the design processes and tools have been refined and re-evaluated by further applied research into local practice. Subsequently, in order to address Research Question 3 (RQ3) during phase three (P3), models, learning design process and tools for embedding digital literacy in a variety of learning scenarios in local practice have been formalised. Initially, the impetus was to establish a common frame of reference of how digital literacy could be defined and contextualised locally within a tertiary healthcare education institution. The digital literacy conceptualisations of the DigComp framework have been investigated for their suitability to describe the digital experiences of healthcare students and staff during phase one, as part of intervention one, by completing actions one and five, in an attempt to address research question one (P1,I1,A1&5,RQ1).

Based on encouraging evidence for the suitability of the framework emerging from the initial analysis of the qualitative evaluation (P1,I1,A1,RQ1), a series of technological-pedagogical interventions, aiming to enhance teaching practice, were designed, implemented and evaluated (P1,I2,A2-4,RQ1). Specifically, online study activities were designed to facilitate learning in aspects of the healthcare curriculum and at the same time evidence technological competency in one or more of the framework areas. Another important objective of the evaluation was to explore the feasibility of quantifying digital literacy by utilising the structure, classifications and skill descriptions defined in the framework. A bespoke digital-literacy self-assessment questionnaire was offered to the participants of the aforementioned teaching-enhancement intervention in an attempt to establish a baseline of the digital-literacy potential of the group and assess the tool performance (Evangelinos and Holley, 2014b). The student experience was evaluated through the written reflective accounts of the participants and wider discussions within focus groups (Evangelinos and Holley, 2015b). During the course of this exploratory phase of the research, which was based on the early results of the DigComp framework (Janssen and Stoyanov, 2012), the first iteration of the framework was published (Ferrari, 2013) in a considerably refined but broadly, as it has been argued in this thesis, compatible format.

Drawing from nationally and internationally established good practices arising from the literature, and by reflecting on the results and experiences of the initial exploratory phase of the research, during phase two the digital-literacy framework and self-assessment tool were revised to match the updated structure, classifications and skill definitions, and subsequently re-evaluated. Significantly, the response format of the digital literacy self-assessment questionnaire has been revised in an attempt to enhance its performance. Employing the same methodological approach, phase two followed closely the approach established in the exploratory phase in order to maintain methodological purity, set the boundaries for further research, debate, and some cautious comparisons (P2,I3&4,A6-10,RQ1&2). In particular, the updated digital literacy self-assessment tool was piloted (P2,I3,A6,RQ1) in an attempt to establish the digital-literacy needs of student nurses when undertaking the electronic assessment of their clinical skills within their practice placement. The student experience was evaluated through the participants' reflective accounts (P2,I3,A7,RQ2). In this enhancement phase, it was deemed important to explore the performance of a staff-specific version of the updated self-assessment questionnaire (P2,I3,A8,RQ1) to explore the digital capabilities of academic staff. The alignment of the digital capabilities of learners and teachers to the digital-competency requirements of a digitally-mediated blended curriculum has been identified as an important requirement for embedding digital literacies in the curriculum delivery during the exploratory phase of the research, as per relevant literature (Kerrigan, Coombs, Walker and Hinrichsen, 2013b; Walker and Kerrigan, 2016). Phase two concluded with an evaluation of the student experience when undertaking learning activities in the classroom by utilisation of mobile devices (P2,I4,A9&10,RQ2). These have been designed by employing the same learning-design approach as in the previous phase.

1.2 The Research Questions

Digital literacy is a general term that signifies competency in using digital technologies. However, its meaning is wide-ranging and not specific enough without further elaboration. In this thesis it has been broadly interpreted to describe the competences, skills and attitudes of people when using digital technologies (Ala-Mutka, 2011; Ferrari, 2012). These skills and attitudes are constantly evolving as technology changes, and individuals become more technologically capable, or acquire new technologically-enabled interests. For the purpose of investigating what digital literacy signified to academics, academic professionals and students, the research question was expressed as:

Q.1 Are digital literacy frameworks useful in supporting student learning in university healthcare settings?

Q.1.1 Are there any specific attributes of digital literacy in a healthcare education environment?

To answer these questions a qualitative exploration of the European Union's DigComp framework (Ferrari, 2013) was conducted within the faculty to assess its applicability for investigating the potentials and limits of embedding digital literacy into the healthcare curriculum-development and delivery (Evangelinos and Holley, 2014a). The initial research question defined digital literacy in relation to the conceptualisations and understanding of the key stakeholders in a higher education environment. A sub-question on whether any specific digital attributes existed in healthcare education was also explored. A significant risk was identified in that the research participants would not be able to comprehend digital literacy as an abstract, higher-level concept. In order to address this issue it was decided that further elaboration on what digital literacy meant was required so as to enable the establishment of a common frame of reference among the researcher and the research participants. This frame of reference had to be defined in a meaningful way for the participants to enable them to express their views and provide evidence arising from their own digital practices. Notably, the framework was structured in a way that could be used to describe digital literacy in a granular way.

For the purpose of investigating a method for developing the digital literacy of learners, and thus teachers, the question was formulated as:

Q.2 In what ways can a framework approach assist us to understand how digital literacies manifest in student learning experiences?

Q.2.1 How can digital literacy be developed in a higher education healthcare environment?

Quantification of digital-literacy characteristics in an education environment, due to the nature of the inquiry and the complexity of educational processes, had to be broken down to include a soft measurement of self-assessed attitudes towards technology (Evangelinos and Holley, 2014b), then a more precise measurement of self-assessed skills (Evangelinos and Holley, 2015b), and finally the remapping of the attitudes, competences and skills of competency profiles (Evangelinos and Kerrigan, 2016). Once a common language to describe digital literacy had been established, and tools to quantitatively measure attitudes and competences in practice had been developed by utilisation of the multi-dimensional DigComp framework, a question on how to best implement these in a model for embedding digital literacy in the curriculum, evolved intuitively. The question was articulated as:

Q.3 How can digital literacy be conceptualised and embedded into a variety of learning scenarios?

Q.3.1 What are the necessary elements for embedding digital literacy in curriculum development?

The end goal of the research was to develop ways to enhance the digital literacies of students and staff. The tangible outputs were: (i) creation of a curriculum-development model, (ii) identification of the related processes and (iii) provision of a framework and tools for embedding digital literacy in curriculum design and delivery. The next few chapters present the evidence, analyses and results of how this journey unfolded, and examine the fundamental ontological and methodological questions that permeated this work-based research. What follows is an account of how the notion of digital literacy was developed in this thesis through interaction with relevant literature published over the last forty years.

Chapter 2. Literature Review

2.1 Approach to Literature Search

A literature search was conducted for consultation purposes of the established body of academic knowledge in the area of digital-literacy development. The search was conducted via an academic library meta-search engine with access to academic databases. Specifically, the academic databases of ERIC, Taylor & Francis, Elsevier, DOAJ, Wiley, SAGE, JSTOR and Springer were searched. The search was complemented by queries in Google and Google Scholar that revealed a number of resources not published in academic journals. The search objectives, as well as inclusion and exclusion decisions for each consecutive round of searches, are illustrated in Table 1. The initial search revealed a wealth of information contained in frameworks, academic papers, case studies, project reports, assessment frameworks, and national and international policy documents. Three consecutive rounds of literature review were conducted following the research plan. Each round was refined as identified in the search strategy log (See Appendix - Search Strategy).

The first round of reviews (steps 1-6) focused on defining digital literacy in learning environments. The search focused on identifying literature relevant to the digital-literacy and digital-competence development in higher education, and within the context of educational technologies. A second round of reviews (steps 7-12) refocused the search from conceptualisations to approaches that can be used to quantify digital-literacy development in practice. The literature was filtered according to relevancy to digital-literacy development and to the context of the study that had to be broadly within education. The review strategy reduced the volume of literature to a more manageable size but increased the risk of missing important resources. For this reason all searches have been complemented with Google and Google Scholar searches. A third round of reviews (steps 13-15) isolated a combination of publications, including frameworks and case studies that were considered highly relevant to digital-literacy development in higher education. The frameworks formulated a basis for establishing a common language, and the case studies, which explored different approaches to digital-literacy development contextualised in higher education institutions in the United Kingdom. These are discussed in relation to how they have informed this research, and in relation to the appropriateness of the approach to be used as a generic framework and as a tool for curriculum development in higher education. The analysis also included some other pieces of relevant work, such as research papers, policy documents and case studies focusing on digital literacy in education.

Search Round	General Themes	Results
(1) Define Digital Literacy (Steps 1-6) Purpose: Identify literature that defines digital literacy Criteria: (i) Relevancy to digital literacy or digital competence (ii) Environment should be situated within the context of a broadly interpreted learning environment including research	Education, Literacy, Internet, Computer Literacy, Information Literacy, Learning, Information Technology, Educational Technology, Digital Divide, Teaching Methods, Education (General), ICT In Education , Teachers, Media Literacy, Web 2.0, Higher Education	154 peer-reviewed sources and 43 books on digital literacy/competence in educational technologies 81 resources were directly used in defining digital literacy; some of them were dealing with the subject in general terms
(2) Digital Literacy Development (Steps 7-12) Purpose: Identify digital-literacy frameworks focusing on approaches that can be used to quantify digital literacy development Criteria: (i) Relevancy to digital literacy development (ii) Environment should be situated within the context of a broadly interpreted learning environment including research	Education, Internet, Learning, Information Technology, Educational Technology, Students Literacy, Teaching Methods, Teachers, Information Literacy, Social Networks, Computer Literacy, Digital Divide, Digital Literacy Programs, Media Literacy, Digital Literacy	136 peer-reviewed sources on digital literacy/competence and 41 books in educational technologies 55 resources were directly used in defining digital literacy; some of them were dealing with the subject in general terms
(3) Digital Literacy in UK HE (Steps 13-15) Purpose: Identify literature of digital-literacy development in higher education in the UK Criteria: (i) Relevancy to digital literacy development in the UK Higher Education (ii) Generic framework suitable to be used as a tool for curriculum development	Education, Learning, Internet Studies, Educational Technology, Information Technology, Students, Teaching Methods, Literacy, Higher Education, Teachers, Teaching, Academic Libraries, Information Literacy, College Students, Librarians, Teacher Education, Computer Literacy, Literacy Programs	A combination of 41 publications (frameworks and case studies) were shortlisted for in-depth review (See Appendix - DLDC Frameworks Case Studies and Assessment).

Table 1 - Literature Review Schedule

2.2 Defining Digital Literacy

Since literacy implies skills and knowledge (Hague and Payton, 2010) what first comes to one's mind is books and printed material. However, due to the increasing digitisation of information, reading and writing transformed to include decoding and encoding of digital media in different contexts (Lankshear and Knobel, 2006). Digital technologies are increasingly occupying space in every aspect of social and economic activities globally, enabling citizens to interact with a variety of digital systems that have become an indispensable part of contemporary societies (Ala-Mutka, 2008). The modes of reading, writing and communicating are not the same as in the past (Coiro, Knobel, Lankshear and Leu, 2008) and digital literacy is considered as a fundamental skill to function and survive in modern, technology-enabled society (Gilster, 1997; Eshet-Alkalai, 2004; Martin and Grudziecki, 2006; Bawden, 2008). Discussion on a concept with such a broad meaning as literacy results in different focuses that depend on the disciplinary ethos and approaches of the investigation. Policy documents make reference to the same concept in various names that eventually produce a jargon difficult to disentangle. Academic papers make the list even longer by adding terms such as new literacies (Coiro et al., 2008), multimodality (Kress, 2009), technology literacy (Amiel, 2004) and the intertwining of digital literacy with information and media literacy (Bawden, 2001; Buckingham, 2003; Livingstone, 2003; Andretta, 2007; Knobel and Lankshear, 2010; Hartley, 2011).

Consensus in understanding digital literacy today is close enough to Gilster's (1997) theory that explained it in terms of computer and ICT skills together with information evaluation and knowledge assembly. Using digital technology competently is becoming an essential pre-requisite to fully participate in modern societies (Ala-Mutka, 2010; Redecker et al., 2009; Redecker, Centeno and Haché, 2010). Information is mainly communicated in digital technology forms, and engagement with digital technology shapes many aspects of contemporary lifestyles which include work, leisure and education (Deursen, 2010). Digital literacy can be understood as the basis for integration of a number of other literacies since as proposed by Martin (2006a, p.157) it is '*a condition, not a threshold*'. The rapid development of the digital domain, and its consequent impact on a person's circumstances, necessitates a fresh understanding of the ramifications of technology use in everyday life.

This interpretation should not be limited to digital skills but also encompass all the indirectly associated changes, including the impact of technology in understanding the media, retrieving and evaluating information, and communicating with others through mobile technologies and the Internet. These technological trends are examined by the various disciplines of media and communication studies, and information sciences. Understanding the way these concepts are changing is important as digital literacy is often explained as intrinsically associated to other literacies (Bawden, 2001; Eshet-Alkalai, 2004; Sefton-Green, Nixon and Erstad, 2009; Ala-Mutka, 2011).

The concept of digital literacy, although originally applied by a number of writers in the 1990s, was established by Gilster (1997). It was described as the capacity to comprehend and use information coming from various digital sources (Bawden, 2008). Gilster's seminal work was initially criticised for offering multiple definitions but, at a later time, this criticism was perceived as a strength (Bawden, 2008). Belshaw (2013) explained this behaviour as the result of the popularity of Gilster's (1997, p.15) view who claimed that digital literacy was about '*mastering ideas, not keystrokes*'. This concept introduced a previously overlooked cognitive quality to his multiple and wide-ranging definitions that could be used by many authors to support their ideas and arguments. Gilster suggested that competent technology-use should include the use of ICT to carry out everyday tasks, and that technology should be complemented with non-technological resources. Gilster's (1997) work highlights the need to examine digital literacy in relation to other literacies. Eshet (2002) reinforced Gilster's argument that digital literacy should expand beyond the aptitude of using digital sources and manifest the mastering of ideas and the ability to use them in real life. A new understanding emerged where digital information, mediated through the Internet, was thought of as an additional source of information in a technological society.

Bawden (2001) summarised Gilster's core elements such as critically evaluating digital resources for their content quality, the building of knowledge from varied and unrelated sources, the ability to use digital technology to communicate, generate tailored information strategies, handle incoming information and benefiting from the affordances of people networks. Thus, to the practical needs of dealing with an enormous amount of information, two new elements were added: a) the value of using cognitive processes along with networked media and b) assessing, publishing and communicating information (Bawden, 2008). This more expansive interpretation of digital literacy in relation to cognitive processes was influential as it shifted the discussion from the narrow interpretation of digital literacy as digital skills, to the broader area of digital cognition.

Digital Literacy Core Elements Gilster (1997)

- The ability to make informed judgements about what is found online, which equates to 'the art of critical thinking', the key to which is 'the forming of a balanced assessment by distinguishing between content and its presentation'
- Skills of reading and understanding in a dynamic and non-sequential hypertext environment
- Knowledge-assembly skills; building a 'reliable information horde' from diverse sources with 'the ability to collect and evaluate fact and opinion ideally, without bias'
- Searching skills, essentially based in Internet search engines
- Managing the 'multimedia flow', using information filters and agents
- Creating a 'personal information strategy' through selections of sources and delivery mechanisms
- Awareness of other people and our expanded ability [through networks] to contact them, discuss issues and get help
- Being able to understand a problem and develop a set of questions that will solve it through the needed information
- Understanding of the importance of backing up traditional forms of content with networked tools
- Wariness in judging validity and completeness of material referenced by hypertext links.

Figure 1 - Digital Literacy Core Elements

A summary of Gilster's Digital Literacy Core Elements (Gilster, 1997 as cited in; Bawden, 2001, pp.247–248). This work heralded a shift away from interpreting digital literacy as mere digital skills to include broader conceptualisations of cognition.

With the emergence of digitally facilitated social networks and 'Web 2.0' technologies, the division between knowledge/information producer and consumer, or author and reader, started to overlap and merge (Gillen and Barton, 2010). Since then these technological innovations have been widely adopted and impacted on what was understood by the term digital literacy. Simple ICT literacy became insufficient as it concentrated on the technical knowledge and skills needed for using digital applications. With the term Internet literacy tool-related knowledge and skills for functioning in networked media-rich environments were suggested. Information literacy and media literacy overlap. However, media literacy is more focused on skills for the interpretation, use and creation of media for an individual's own benefit and participation. The breadth and depth of digital literacy as a topic, the multiple domains under which it manifested, and the interchangeable way the definitions were used, created confusion in terminology (Eshet-Alkalai, 2004), mainly due to controversy of the beliefs of those who supported that digital literacy should focus on technical skills (Hargittai, 2005; Williams, 2006; Kauhanen-Simanainen, 2007) and those who focused on the cognitive aspects of working in a digital environment (Burniske, 2008).

The overlap and co-existence of multiple forms of information production and dissemination necessitated a shift towards a more holistic definition. Gillen and Barton (2010, p.1) defined digital literacy as '*…the constantly changing practices though which people make traceable meanings with digital technologies*'. Digital literacy is a transversal concept that encompasses concepts from ICT, information, media and network literacies in the digital domain. It includes the abilities of planning, executing and evaluating digital actions, obtaining and utilising knowledge, techniques, attitudes and personal qualities for the provision of successful solutions and the capacity for self-reflection on one's own development needs. An evolved definition emerged from Futurelab's work on mapping digital literacy and was described in generic terms such as knowing, communicating, understanding, and influencing (Grant, 2009).

A number of scholars emphasised the plural term 'digital literacies' to highlight the individuality of experiences with a particular focus on social practices (Marsh, 2004; Lankshear and Knobel, 2008, 2011). Other researchers deliberately avoided using these terms and described their findings in terms of a transition from traditional to digital practices, and as potential enablers for effective learning (Beetham, McGill and Littlejohn, 2009). Belshaw (2010) questioned the necessity for digital distinction as it was born by the experiences of older generations, and it did not apply to young people belonging to Generation Z or the New Boomers. The conceptual difference is that younger technology users normally do not have any pre-digital experiences and, as such, the term digital is ambiguous. Belshaw (2010) highlighted the importance of acquiring procedural skills that enable individuals to use technologies, but also recognised the existence of other wider developmental aspects. Reflecting on the variety of digital literacy definitions, the related complexity of approaches, as well as on the arguments of intra-generational interpretations, it was considered as pertinent to examine the historical background of how the concept of digital literacy evolved along the development of technologies. What follows is an account of relevant conceptualisations of technology use, reviewed as historical evidence for the development of digital literacy that is considered as a wider multi-faceted concept.

2.3 Digital Literacy Development

In the 1980s a variety of definitions that could be categorised under the concept of computer literacy developed and remained unchanged for more than two decades (Oliver and Towers, 2000; Reed, Doty and May, 2005). Initially, computer literacy was characterised mainly by the acquisition of operative and technical skills and the knowledge of using computers and software. Bawden (2001) observed that the literature definition for computer literacy was skills-based and involved the use of software packages alongside the possession of some generic operating-system skills, essential for operating the computing devices. Van Deursen (2010) also accepted that this vocational approach was common in literature and highlighted the limitation of the approaches, identifying computer literacy as tool-centred and specific to the technologies used.

During the 1980s the need to use technologies more reflectively emerged, as technologies were becoming widely available and had started being used in a variety of increasingly complex tasks by non-expert users. This resulted in broadening the understanding of what computer literacy should be, and more inclusive elucidations appeared (Martin, 2008). Horton (1983 cited in Bawden, 2001, p.226) in the definition of computer literacy introduced the concept that literacy included the understanding of capabilities and limits of technology, '*…computer literacy has to do with increasing our understanding of what the machine can and cannot do…*'. Hunter (1983 cited in Bawden, 2001, p.226) steered the discussion to the information-based society by defining computer literacy as '*whatever a person needs to be able to do with computers and know about computers in order to function in an information-based society*'. Husen and Postlethwaite (1985 cited in Bawden, 2001, p.226) defined computer literacy as '*…whatever understanding, skills and attitudes one needs to function effectively within a given social role that directly or indirectly involves computers*'. Haigh (1985, p.161) offered a similar definition '*…that compendium of knowledge and skills which ordinary educated people need to have about computers in order to function effectively at work and in their private lives*'. Both definitions expanded in very generic terms the skill-based definitions to include provisions for the effective use of technology within society.

This emerging expansion of the concepts was necessary as in practice it was observed that the computer technology had profoundly changed the ways in which information was searched, retrieved and communicated. Shapiro and Hughes (1996), investigating how computer literacy could be integrated in the curriculum in practice, identified a number of related characteristics. Acknowledging that the skills to use computer software and hardware were a fundamental requirement, they identified that, although qualitatively different, the comprehension of different information sources and the social dimension of the creation of information were equally important aspects. It was essential to establish how technology could be used for scholarly activity, regarding the newfound capabilities of technology in publishing and self-publishing. Crucially, they also identified an inherent need for embracing change and developing the ability to critically evaluate the affordances of new technologies that were necessitated by the continuous technological innovation. The US National Research Council introduced the term IT fluency to describe ICT literacy in an attempt to expand the definition so as to include critical thinking, cognitive processing and evaluation of information beyond technical skills (Committee on Information Technology Literacy National Research Council, 1999). ICT literacy was consequently transformed to include aspects of Information Literacy. Several authors saw these as distinct but inter-related concepts and discussed their relationship (Bawden, 2001).

Towards the end of the 1980s and during the 1990s the authors turned their interest to Information Literacy, a term that was used extensively in higher education. The American Library Association (1989, p.1) proclaimed that '*To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information*'. Brouwer (1996) saw information literacy in the centre of critical thinking. Criticality was conveyed, in terms of aptitude, as the ability to discern the differences of information and knowledge, identifying the basis and hypotheses in the information, judging the value, schedules, precision and integrity of information and upraising the results and conclusions by utilising technologies. Bruce (1994, 1997) identified the information-literate person as an independent and critical thinker, self-sufficient learner, competent in the use of various technologies and systems, and in the utilisation and creation of knowledge and information. Bawden (2001) observed the existence of a link connecting information literacy and learning, and stressed that information literacy was a tool necessary for lifelong learning.

In 1999, the Society of College National and University Libraries (SCONUL), a group working on Information Literacy in the UK, developed the seven pillars of an information-literacy model (Society of College National and University Libraries (SCONUL), 1999) based on the American Library Association's previous work. The two models are in many respects similar to one another but, the seven pillars appear different in some areas such as these of acknowledging the requirements, creating, locating, accessing, organising, synthesising and applying information. They are also dissimilar in the ways of comparing and evaluating, and of the implementation scope. Eventually, the National Council for Curriculum and Assessment (2004, p.51) redefined these ideas to encompass '*the knowledge, skills, and attitudes necessary to participate fully in the information society*'. This broader approach was described in terms of cognitive processes that presupposed thinking skills of a higher order. The International Federation of Library Associations and Institutions (IFLA) (2005, p.1) with the Alexandria Proclamation of 2005 established Information Literacy as a human right and declared that information literacy '…*empowers people in all walks of life to seek, evaluate, use and create information effectively to achieve their personal, social, occupational and educational goals*'. The United Nations Education Scientific and Cultural Organisation (UNESCO) in their response, and in an attempt to establish indicators, elaborated these concepts further in Catts and Lau (2008, p.7) work, and defined information literacy as '…*the capacity of people to: a) Recognise their information needs, b) Locate and evaluate the quality of information c) Store and retrieve information d) Make effective and ethical use of information and e) Apply information to create and communicate knowledge*'. The expanding volume of pieces of information alongside the transformation of the information sources afforded by new technologies emphasised the importance of critical thinking.

Eventually the use of the term computer literacy started declining and being replaced by the term Information and Communication Technology (ICT), primarily for two main reasons. The previous use of the term, closely linked to specific computer skills and the use of software packages, became contradictory (Talja, 2005; Johnson, 2007) when trying to give computer literacy a broader meaning encompassing the intellectual prowess an individual needed to interpret textual literacy and, later on, to include other media in the digital domain (Disessa, 2000). This shift coincided with technological developments that allowed the commercialisation of faster internet connections that eventually transformed the World Wide Web through the creation of new and innovative services. As a result of these technological developments the terms internet literacy and network literacy emerged to describe processes that were relevant to communicating, using media and other digital assets, working with and, importantly, understanding the networked nature of information. McClure (1994) suggested that the primary features were knowledge and skills. Knowledge included awareness for the potential uses of networked assets, understanding of how networked information can be used in solving problems in everyday life activities, comprehending the system mechanisms, and how information is produced, managed and presented. In this context skills were defined to include the ability to retrieve, manipulate and use networked information. In the USA McClure (1994) evaluated the various literacy policies (information, media, ICT) at that time, noted that they were interrelated, and that, in an educational context, they should be considered together in relation to solving real-life problems across academic, personal and work contexts, instead of being perceived as separate from other literacies.

Internet literacy has been used extensively, although informally, as a term. This concept has little been discussed in academic discourse. It concerns the using of the internet for teaching, or learning about the internet, primarily within an educational context. The term is rather synonymous to network literacy, as there are no decisive differentiations in the use or the meaning of the terms (Martin, 1997). Van Deursen's (2010) discussed the existence of distinct internet skills that could be categorised in two types, medium and content skills. Medium skills concerned the technical capacity of using the internet while content skills concerned negotiating and working with information on the internet. These skills have been applicable in managing content in diverse disciplines. Ala-Mutka (2011) discussing van Deursen's (2010) work observed that the definition on classifying content skills was closely akin to the definitions of information literacy. Along with the development of technology, the ways of communicating and accessing information developed. The types of content transformed to include multimedia messages that eventually became common ground through the recent explosion of user-generated content (Statista, 2017).

The Characteristics of Information Literacy

- Appreciation for the nature of information and technologies including the limitations of computer-mediated information search.
- Organising, manipulating, analysing and critically appraising the information as well as presenting the findings.
- Choosing and evaluating the appropriate sources with reference to the existing literature structures, understanding of semantic interpretation methods and distinguishing between exact and widespread searching.

Figure 2 - The Characteristics of Information Literacy

The main characteristics of information literacy (Bawden, 2001). Bawden (2001), commenting on the findings of Dupuis (1997), suggested that the main characteristics of information literacy were based on printed literature and the Internet.

By the end of the 1990s the term media literacy started developing for the purpose of describing socio-technological changes. Originally it was understood in the context of information literacy and described in terms of the conventional mass media, for instance audio-visual (radio and television), print (newspapers and magazines) and, at a later time, the Internet (Kubey, 1997). Lanham (1995) identified the need for developing multi-media literacy since texts, images, sounds and other forms of information could be generated by digital sources. Bawden (2001) observed a connection of media literacy and information literacy due to their intrinsic, shared connection of information management. Livingstone, van Couvering and Thumim (2005, p.12) attributed the '*…identification, location, evaluation and use of media materials*' as characteristics of information literacy. The most prominent definition in literature is this of the Aspen Media Literacy Leadership Institute, documented by Aufderheide (1993, p.6) in the report of the 1992 National Leadership Conference on Media Literacy which defined media literacy as '… *the ability of a citizen to access, analyze, and produce information for specific outcomes*'. The definition has been modified and used widely by others (Thoman and Jolls, 2003; Center for Media Literacy, 2011).

In the United Kingdom, the Office of Communications (OFCOM) (2008, p.4) defined media literacy as '*the ability to access, understand and create communications in a variety of contexts*'. It should be noted that information literacy – similarly to the media literacy and particularly influenced by internet use – started with the ability to access, retrieve and understand information. Martin (2006b) discussing the relationship of information and media literacies noted that the former was concerned mainly with the access and evaluation of information, while the latter was dealing with a variety of media and the different types of information/communication methods. Bawden (2008) established that information and media were defined by the ability to retrieve and use information and managing different information (media) formats. These qualities differentiated information and media literacies even though these were closely inter-related.

Media education is concerned with the critical evaluation of information and the understanding of the purpose and mechanisms for communicating projected messages. This communication/interpretation component includes the understanding of media-message targeting, together with the various ways of constructing messages and it is central to the definition of media literacy (Buckingham, 2003). This area expanded to encompass new forms of communication including the use of new media technologies and the Internet (Livingstone, 2003). Media literacy requires higher-level competences that presuppose critical thinking and reflection. Brandtweiner, Donat and Kerschbaum (2010) defined these higher-level cognitive abilities as a) appropriate selection and use, b) appraisal and comprehension, c) reflection and self-awareness of the content influence and d) identification and appreciation of the circumstances of production. These literacies have been interpreted through the interplay between the affordances of digital technology and the context of the literary investigation.

The digital-literacy literature highlights the increasing complexity of the terms, and the ways in which different audiences (academics, researchers, national governments and international institutions) interpret the impact of digitisation on modern societies and respond to the shifting policy arena. The development of the various literacies, examined in respect to their digital manifestations, can be broadly interpreted by reference to skills, knowledge and application. Therefore, it is important to examine digital skills in the context of the field and the nature of the inquiry, and recognise that increasing digitisation of our everyday life aspects is affecting our various practices which are shaped by digital affordances.

Historically ICT literacy was conceived as the ability to use computers and was characterised by the skills needed to operate the various hardware/software systems. As information started being increasingly communicated digitally, the need for criticality emerged and signalled a shift of the focus from skills to knowledge. This resulted in refocusing the inquiry towards the concept of information literacy. Digitisation of multiple forms of media contributed to this need and further expanded the field of enquiry. The phases of digital-literacy transformation were affected by the popularisation of digital networks and the Internet that allowed for the exchange of information across geographical locations with unprecedented speed. These developments resulted in new and innovative uses of technology. The pervasiveness of digital technologies inevitably increased the inter-connectedness of what traditionally was seen as separate literacies and transformed their applications into new forms of multimodal literacies. In this respect digital literacy is an overarching concept encompassing the digital expressions of all the other literacies.

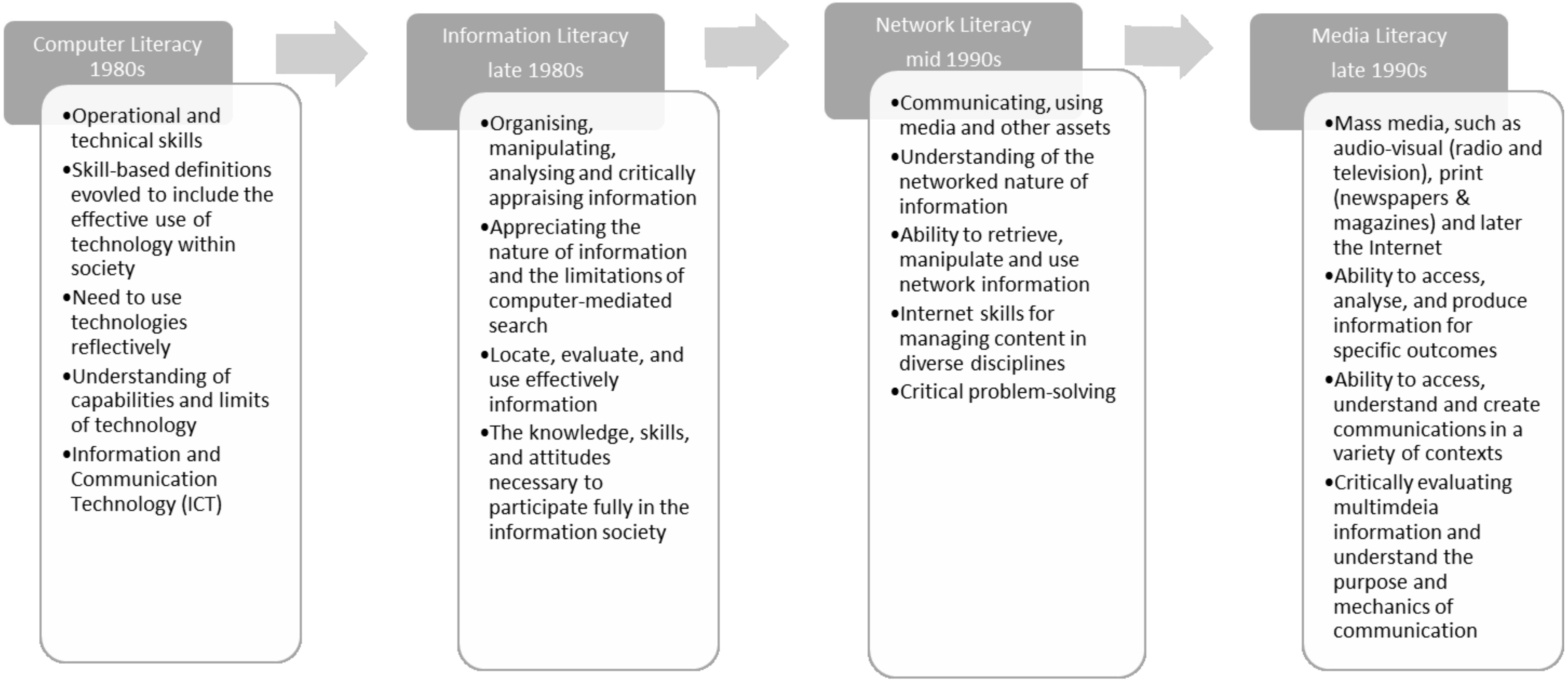


Figure 3 - Timeline of Digital Literacy Development

The timeline of digitally-related development of literacies, as it is arising from literature. The natural alignment of the literacies and the concepts that evolved alongside the technological advances and innovations should be noted.

The inter-connectedness of the various literacy concepts, in combination with the continuing developments in digital technology, necessitated the development of appropriate frameworks for the purpose of unification of these seemingly disparate concepts and the facilitation of a shared understanding. Common understanding is particularly important in education since, at the core of learning, the mastery of these literacies dominates. The use of digital technologies, situated within different contexts, is designed to deliver skills and knowledge, enable understanding, deliver the capacity for application and, ultimately, enable innovation. The section that follows analyses digital literacy conceptualisations appropriate to educational development.

2.4 Conceptualising Digital Literacy

A considerable amount of literature on digital-literacy frameworks upon which digital competences can be based, has been published (Rosado and Bélisle, 2006; Martin, 2006a; Martin and Grudziecki, 2006; Kempster Group, 2008; Beetham and Sharpe, 2009; Reedy and Goodfellow, 2012; Stordy, 2015; Biggins, Holley, Evangelinos and Zezulkova, 2016; van Laar, van Deursen, van Dijk and de Haan, 2017). Understanding of the background and origin of these frameworks informed the empirical work of this thesis. The literature was reviewed periodically with the aim at producing an evidence-based theory for the development of quantifiable digital literacy within a higher educational institution. The theoretical basis for the kind of empirical research described in this thesis was gradually developed and influenced by a number of concurrent developments. The frameworks, case studies and research papers were evaluated on the premise of how they could potentially relate to the research, and invariably created a stable basis for ideas and further thinking. It should also be noted that this research was carried out within the wider context of Technology Enhanced Learning (TEL) and pedagogies in higher education. Although a significant volume of literature, deriving from the available material, was in various ways relevant, it was decided to focus specifically on the topic of digital-literacy frameworks and other directly related work.

Digital-literacy literature in broad examination can be categorised in three main types: a) digital literacy frameworks, b) case studies of projects and other research initiatives, and c) assessment and accreditation frameworks. The accreditation frameworks have not been analysed in detail as their relevance to the research was considered only from a validation perspective. It became apparent that digital literacy is a complex concept which cannot adequately be expressed only in terms of standardised-skill tests. Developing digital literacy presupposes a common set of definitions and conceptualisations. The included frameworks and case studies have informed the research-design of this doctoral work in a significant way, and have been selected for further analysis and discussion in respect to relevant ideas, approaches and findings. Initially the focus of the search was to define digital literacy and establish a theoretical background of how digital literacy can be contextualised within education with emphasis on the approaches that could produce quantifiable results.

2.4.1 Digital Literacy in Praxis

In his framework Eshet-Alkalai (2002; 2004) used the terms photo-visual, reproduction, information, branching and socio-emotional literacies to describe digital literacy. In this work the applicability of his proposed framework was investigated by utilising a task-based approach to explore scenarios of digital use. The ability of participants to answer questions, complete tasks and solve problems by undertaking task-based assessments that utilised different types of digital competences was measured. The study included participants from different group ages that included secondary-school ages, university students and adults over the age of thirty. The total number of participants amounted to thirty, a relatively small number to confidently allow for generalisations. Therefore, he concluded that these types of literacies could be used as a framework to further analyse how individuals of different ages tend to engage with problem-solving and learning in digital environments. The task-based approach was considered to be advantageous for exploring digital literacy in a quantifiable way.

Eshet-Alkalai (2004), based on the results of Springer (1987) and Aspillaga (1996) that demonstrated a correlation between photo-visual competence and reaction time in digital environments, highlighted the relevance of photo-visual literacy when using digital technologies. Photo-visual literacy refers to an individual's ability to comprehend visual stimuli in the context of Graphical User Interfaces (GUIs) and human/machine interactions. Eshet-Alkalai and Amichai-Hamburger (2004) found that school and college participants did not demonstrate any significant differences but both groups did much better than the adults when their photo-visual literacy was measured in terms of interpreting GUI changes. Eshet-Alkalai (2004, p.95) re-defined the use of such multimedia photo-visual communications in learning as '*synchronic learning*' and specified '*synchronic literacy*' as a special case of photo-visual literacy. In the framework reproduction and information they are identified as separate literacies, although reproduction is based on and defined by reference to information literacy. Eshet-Alkalai (2004, p.98) based on work from Gilster (1997) and Labbo, Reinking and McKenna (1998) defined reproduction literacy as the proficiency '*…to create a meaningful, authentic, and creative work or interpretation, by integrating existing independent pieces of information*'. Eshet-Alkalai (2004) emphasised that information literacy involved the cognitive abilities of selecting, critically appraising, and using information efficiently. This view was also shared by Gilster (1997) and Minkel (2000). Inadvertently, 'Branching' or 'Hypermedia' literacy became prominent with the advent of the hypertext that allowed for cross-referencing of the information traversing multiple fields of knowledge. From an educational perspective, searching and managing information across different knowledge domains through the affordances of hypertext and hypermedia forking and linking, encourages cross-disciplinary and expanded thinking (Eshet-Alkalai, 2004).

A significant component of Eshet's (2004) digital-literacy conceptual framework is socio-emotional literacy. Confusingly this term is defined in relation to information and branching literacies as a socio-emotional state where individuals demonstrate competence in analytical and critical thinking-skills combined with a mature attitude and mastery of language. This concept is based on the findings of socio-psychological, internet-use profiling research (Hamburger and Ben-Artzi, 2000; Amichai-Hamburger, 2002; Mundrof and Laird, 2002). It describes socio-emotional competence as the abilities of critical evaluation of information, abstract thinking and a disposition to share information, collaborate and co-create knowledge.

2.4.2 Developing Digital Literacies in Education in Europe

In pursuit of establishing how digital literacy could be expressed in an educational environment the DigEuLit (2006) project aimed at developing a digital-literacy framework and tools that could be used to acquire a shared understanding of the concept of digitally-literate teachers and students across Europe (Martin and Grudziecki, 2006). Martin and Grudziecki (2006, p.255) defined digital literacy as '*…the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process…*'. The framework was organised in three distinct levels of development: a) digital competence, b) digital usage and c) digital transformation. The technical skills, conceptual knowledge, attitudes and approaches formulated the basis of digital competence. At a more advanced level digital usage was understood through situated practices such as these that can be found in professional and discipline, or domain-specific applications of technology. Finally, the most advanced stage was that of digital transformation that was considered as the ultimate goal, and was described as the creative and innovative use of technologies.

The results indicated advantages in preparing the students for the digital aspects of the courses by utilising a task-oriented approach more interactive than the generic skill-based approaches. It enabled the tutors to acquire a rather rounded view of the digital-literacy requirements of their courses and the corresponding developmental needs of their students for the duration of their programmes of study, across different disciplines. Shortcomings of the research approach have been identified in the conceptual and practical application levels. The definition of the primary digital-competence level includes skills, attitudes, concepts and approaches. Nevertheless, there is not enough detail to explain how these varied and complex concepts can be sufficiently determined to become measurable, although the approach is suitable. The task-based approach tried to overcome some of these issues by defining digital competence in specific contexts via problem-based enquiries. It is not apparent how this problem-based digital competence and the associated literacy characteristics are assessed within the student toolkit without the setting of problem-based assessments first. Linking to the training resources is a great enabler for the development of student competences, but unclear as to how this is done, and as to the basis or the criteria used. If the approach, situated within a discipline, is problem-based rather than generic and skills-based, it is hard to see how digital-literacy training courses, material and resources can be created in a way that will match the rest of the process. The problem could be partially overcome by restricting the digital competence to a given set populated in the library, although this practice could limit the variety of disciplinary-based approaches, and could be characterised as restrictive.

Of particular interest were the results of the application of this framework as they offered insights into a process for enhancing digital-literacy development within an educational institution. The application of the personal development portfolio, owned and supervised by students, was considered as beneficial when used as an evidence-based showcase of digital competences that demonstrated digital literacy in a discipline. The problem-based approach for developing suggested digital competences could be applied in practice and defined in terms of fundamental, transferrable elements which could be structured further by designing a modular scheme that would allow for cross-compatibility among the different tools and development stages. Modelling digital literacy as a series of activities of technology-use, aiming at solving a variety of problems, was considered to be an appropriate tool to study digital-literacy development in education. It also became apparent that a flexible approach was needed to accommodate a variety of uses of digital technology when operating within diverse disciplines.

2.4.3 International Competence Standards for Teachers

Acknowledging the importance of continuous professional development, the United Nations Education Scientific and Cultural Organisation (UNESCO) (2008c) established ICT Competency Standards for Teachers (ICT-CST) in response to the Geneva Plan of Action adopted by the World Summit on the Information Society (WSIS) (2003) in collaboration with industry. The policy framework, a standard for structuring, creating and delivering ICT professional development to teachers of educational institutions, was supported by implementation guidelines (2008b), an explanation of the competency standard modules (2008a), and a teacher professional-development curriculum-specification document (2011). The framework, which targeted to governments and government institutions, established the elements of the required educational changes by articulating the specific ICT skills required by teachers to incorporate ICT into teaching and learning. Guidelines for the design of professional-development training programmes, leading to harmonised teacher qualifications, were also ascertained. The framework and guidelines recognised the fact that different countries were in different stages of development and that there might have been different scopes and approaches for its application. The underlying assumption was that literacy was based on the premises of life-long and life-wide learning, setting new learning objectives and participating in a global learning society that would be founded on knowledge-creation and its dissemination (United Nations Education Scientific and Cultural Organisation, 2008c). Other aspects of policies were the economic growth and the increase of productivity, both linked to the increased use of ICT tools (Guttman, 2003). The educational reform was conceived as an instrument to enhance modern economies by increasing productivity through technology use, utilising information to achieve problem solving, and transforming societies through the introduction of innovative knowledge.

Three stages of development were defined by The United Nations Education Scientific and Cultural Organisation (UNESCO) (2008b, p.7) as '*Technology Literacy*', '*Knowledge Deepening*' and '*Knowledge creation*'. These stages of development are progressive and permeated by five components that constitute the educational functions: a) pedagogic knowledge, b) professional practice and development, c) curriculum development and assessment, d) institutional organisation and e) administration. In this framework the areas of development intersect the educational functions with the ICT-use being ubiquitous in all areas. This approach necessitated changes in the teachers' functioning, the pedagogic models and, inevitably, the teachers' training (Makrakis, 2005).

Technology literacy referred to the teachers' capacity to using technologies innovatively, and incorporating ICT into teaching by utilising appropriate pedagogies which included facilitation of peer learning and team-work, support of student dialogue and interaction, and the development of an engaging environment for social interactions and collaborative learning. The next stage of development, identified as knowledge-deepening, involved engagement with complex problems by using previously acquired knowledge to address real issues met in the workplace and in everyday life. This stage required a different approach to curriculum structure and delivery, turning the focus on understanding and application rather than on knowledge. The teacher's role was transformed from a disseminator of knowledge to a facilitator of student learning. The last stage of development was knowledge creation which involves innovation and active participation in the knowledge society. At this ultimate stage of development collaboration, communication, critical thinking, creation of new knowledge and general innovation were required. Teachers became role-models by engaging with their own personal and professional development, researching and innovating in their disciplines. They facilitated student development by introducing learning experiences that allowed the students to collaboratively apply their skills, reflect, learn and solve problems. It was envisaged that, at this final stage of development, the whole institution would participate in the creation, delivery, and promotion of learning.

Policy and Vision	Technological Literacy	Knowledge Deepening	Knowledge Creation
Curriculum and Assessment	Basic Knowledge	Knowledge Application	21st Century Skills
Pedagogy	Integrate Technology	Complex Problem Solving	Self-management
ICT	Basic Tools	Complex Tools	Pervasive Tools
Organisation and Administration	Standard Classroom	Collaborative Groups	Learning Organisations
Teacher Professional Development	Digital Literacy	Manage and Guide	Teacher as Model Learner

Table 2 - UNESCO ICT-CST Competency Standards Modules

The UNESCO ICT-CST Competency Standards Modules mapped against the five areas of development and across the three progressive stages of competency (United Nations Education Scientific and Cultural Organisation, 2008b).

Advantages have been identified in the flexible structure of the framework that allowed its use at multiple stages of development. The three stages of competency, that tend to increasingly build on each other, demonstrate how this framework can be used to structure a continuous development process. The first stage primarily deals with the acquisition of ICT skills relevant to education. Focusing on the educational applications of technology it allows the teachers to build solid foundations of the necessary digital skills and competences. The second stage develops the pedagogic use of ICT skills to address problems and acquire more complex skills and competences by focusing on pedagogies, and learning and teaching methods. The third stage, as the most advanced, enables teachers and students to become partners in the co-creation of knowledge that is required for innovation.

This framework is relevant to curriculum development, although only indirectly applicable as a professional-development, high-level framework, since it does not specify the skills and competences that constitute digital literacy. However, it describes in some detail the expected outcomes required from teaching professionals, and highlights their role and involvement in defining the best ways for incorporating technology into the curriculum-design and delivery. The technical skills and cognitive competences needed for this purpose are not specified or classified. As such, the framework could more suitably be used as a high-level guide, rather than as a comprehensive framework for developing digital literacy. An important aspect of this professional-development framework is that it rightly focuses on the teachers' personal and professional progression and presupposes that their roles would evolve, thus shifting the focus from teaching to facilitating learning, and ultimately leading to innovation. If this tendency is considered with regard to the pace of technological change and appropriateness of technology-enhanced teaching and learning approaches when operating within diverse contexts and educational scenarios, the aspect of the framework previously described becomes really significant. The five areas of development have been used to conceptualise the main themes of fostering digital literacy in education, while the progressive stages of teacher development have highlighted the importance of enhancing the digital capabilities of teachers and of embedding digital literacy in the curriculum design and delivery.

2.4.4 Standardising Digital Literacy in Europe

In response to these international developments and in recognition of the growing importance of developing digital capabilities, the European Parliament and The Council of the EU (2006) established Digital Competence as one of the eight Key Competences for Lifelong Learning as a response to the international agenda for supporting digital innovation (United Nations Education Scientific and Cultural Organisation, 2014). In the Key Competences Recommendation, The European Parliament and The Council of the EU (2006, p.4) define competence as '*a combination of knowledge, skills and attitudes appropriate to the context'*. The European Qualifications Framework (EQF) established competence as the most sophisticated component of the structural descriptors. It is defined by the European Centre for the Development of Vocational Training (CEDEFOP) (2014, p.1) as '*the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development',* and is explained in terms of responsibility and independence. Both definitions establish competence as the overarching entity encompassing knowledge, skills and the ways for their application, including the EQF responsibility and autonomy which are personal, social and methodological attitudes.

In the Europe 2020 Strategy (European Commission, 2010) the value of the European Parliament and The Council of the EU (2006, p.7) recommendation was recognised, and Digital Competence was defined. We read that '*Digital Competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet*'. Digital competence is instrumental in developing other abilities and skills. Ferrari (2012, p.1) defines it broadly as '…*the confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society*'. Ferrari (2012, p.4) also offers a more elaborate definition describing digital competence as '…*the set of knowledge, skills, attitudes (thus including abilities, strategies, values and awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively,* *efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socialising, consuming, and empowerment*'. The first definition is broad and generic, while the second is all-encompassing and attempts to define the meaning of being digitally competent by describing the required knowledge, skills, attitudes and areas of potential use.

Eventually, the Joint Research Centre (JRC) was tasked by the European Commission to investigate the implications of developing these core competencies. Digital competence was allocated to the Institute for Prospective Technological Studies (IPTS) which was commissioned to identify the key components of Digital Competence, to develop a digital-competence framework that could be validated at European level, and to propose a roadmap for the use and revision of a Digital Competence framework (Ferrari, 2013). Early in 2011 IPTS initiated the Digital Competence (DigComp) project that aimed to establish a common understanding of what constituted digital competence across Europe. Ferrari's (2012, p.21) definition of a digital-literacy framework, originally developed by the European Centre for the Development of Vocational Training (CEDEFOP) (European Centre for the Development of Vocational Training (CEDEFOP), 2008) is employed to mean that '*any organised conceptualisation of the competences and sub-competences related to digital literacy*'. Therefore, a digital literacy/competence framework is understood as '*an instrument for the development or assessment of Digital Competence according to a set of criteria, which establishes descriptors of intertwined competences aimed at enhancing the digital literacy of a specific target group*'. This definition is notable as it characterises the framework as an instrument aiming at developing the digital literacy of a specific group. It was constructed to be flexible, and was acknowledging the complexity and interweaved nature of the described competencies. The combination of these three elements, alongside the granular and detailed descriptors of the competency areas, were at the time unique features.

The DigComp framework was developed in several stages. It commenced with an initial investigation of the state of the art on how digital literacy/competence was understood (Ala-Mutka, 2011) and an analysis of relevant digital-competence frameworks, projects and other initiatives (Ferrari, 2012). The fact-finding exploration stage was followed by an extensive consultation of the views of expert stakeholders on the fundamental elements of digital competence (Janssen and Stoyanov, 2012), subsequently refined and validated (Janssen et al., 2013). Specifically, the study utilised an iterative Delphi-type approach which included 79 experts representing a variety of professional and academic sectors, areas of knowledge, and socio-demographic backgrounds, and completed the online survey with their expert views. The questionnaire data was subsequently processed to exclude duplicates and sanitise complex ideas. Then a workshop, in which 17 experts took part, classified the proposed digital-competency statements and sought consensus on the broad areas and the more detailed descriptions. A second online survey consulted 57 experts to validate and rank the areas, and enhance the definitions. This process resulted in identifying 12 high-level areas with 5 descriptive statements each. Thus, consensus was established by 95 experts coming from every European country except Poland, Switzerland and Luxembourg (Janssen and Stoyanov, 2012; Janssen et al., 2013). Based on the validated results of the online consultation, the initial version of the DigComp framework was proposed (Ferrari, 2013).

For the creation of the DigComp framework previous studies measuring some of its components (e.g. PIAAC, PISA 2012, PISA 2015, ICILS 2013) had been identified and considered in relation to digital literacy (Ferrari, 2013). The classifications, developed and refined throughout the various stages of development, were organised in broad digital-literacy themes which were further described in skills and attitudes. The DigComp framework proposal included five dimensions for examining digital literacy: a) digital literacy areas, b) competences, c) proficiency levels, d) examples of knowledge, skills and attitudes and e) purposes (Ferrari, 2013). This structure is an extension to the e-Competence four-dimensional framework (European Committee for Standardization (CEN), 2014) with the addition of the dimension of purposes in order to allow for contextualisation. The framework adopted the Common European Framework of Reference for Languages (CEFR) method of using descriptors to define three levels of competence presented in the form of a self-assessment grid (Council of Europe, 2014). The original DigComp framework (version 1.0) used the European Qualification Framework (EQF) criteria (European Commission, 2015) to establish the competence areas but resolved in using three threshold levels rather than eight of the EQF. Ferrari (2013, p.9) defined these threshold levels as extending from *'…"being aware and having an understanding of" (A level - Foundation) to "being able to use" (B level - Intermediate) up to "being actively involved in as a practice" (C level - Advanced)'*. It should be noted that in the more recent iteration of DigComp (version 2.1) the full EQF structure with its eight competency levels was utilised (Carretero, Vuorikari and Punie, 2017).

In summary, the DigComp study aimed at developing a flexible framework that could be used in a variety of ways to describe digital literacy. One major advantage of the study was the unusually large-scale consultation of 95 experts that strengthened the dependability of the results. The granular structure and clarity of definitions were two aspects of considerable value when exploring digital literacies. However, it can be argued that grounding the research on the opinions of experts is not necessarily a reliable approach and an attempt to mitigate this methodological weakness has been made by corroborating the results in two separate rounds for further validation consultations. Ferrari (2013) stated that the methodology of the consultation process had not been piloted or tried in practice before. It was also recommended that, due to the complexity of the framework, it should be adapted and simplified to suit individual needs. Individual competences, skills and attitudes are recognised as central to the development of digital literacy. Therefore, adaptation and further research into the specific contextual aspects is encouraged. Another important matter is the rapid change of technology and the consequent evolution of practices. Although competences are reasonably broad in context and abstract enough, there will be need these to be revised in future. Defining digital literacy in descriptors of competences, skills and attitudes, alongside qualification levels that were compatible with established competence frameworks, was a powerful combination that made the DigComp framework suitable for embedding digital literacy in the curriculum. Since its inception, the framework in its various iterations has been used to align projects, programmes and accreditation initiatives across Europe and beyond.

2.4.5 The JISC Digital Literacy Development Programme

At the time of conducting the research presented in this thesis, digital-literacy development was investigated across a number of Higher Education institutions in the UK through the Digital Literacies Development Programme (Joint Information Systems Committee (JISC), 2013). The initiative was informed by the findings of the LLiDA Project (Beetham, McGill and Littlejohn, 2009) on learning-development frameworks. The objectives and approaches of the initiatives varied across the institutions and documented a multitude of digital-literacy development aspects in the UK Higher Education. Beetham (2013b, p.1) synthesised the case-study results under six prominent areas:

a) developing the digital literacy of students and staff in academic and professional contexts;
b) digital-literacy quantification and development;
c) student participation; Bring Your Own Device (BYOD) and Bring Your Own Skills (BYOS);
d) students as agents of change;
e) change management; and
f) evaluation of the development of digital literacy.

This thesis is contextualised within the boundaries of the first two areas. It was informed by the identified relevant good practices, in an attempt to develop the digital literacies of learners and academics in a quantifiable way. The case studies from the programme, alongside some additional key studies, are discussed below in relation to their relevance to this research work. A summary of the drivers, outputs, lessons learnt and sustainability of the case studies can be found in Appendix - Jisc Case Studies Developing Digital Literacy Programme.

Preliminary work, carried out through the Exeter Cascade project (University of Exeter, 2017), identified a number of aspects that had to be considered in digital-literacy development. The outcomes suggested that digital literacy should be personalised, developed strategically at the institutional level, and involve students as agents for change. However, a variety of challenges for students and staff in becoming digitally literate were acknowledged, including considerations for the appropriateness and effectiveness of monolithic approaches within diverse disciplines and departments (Beetham, 2012). The areas, identified in the baseline results, constitute evidence of the complexity of implementing change in higher education. Of particular relevance were the areas of personalising digital literacy, the challenges in student and staff digital-literacy development, and the implementation of change in a discipline or a department. The Cascade project, alongside the case studies that follow, shaped the work of this thesis due to the shared aim for developing the digital literacies of learners and teaching/research staff by focusing on the use of digital technologies for the purpose of encouraging active participation.

2.4.5.1 Cardiff University - Digidol

A systematic approach to embedding digital literacy for the development of students, academics and academic-related staff was explored by the Digidol project at Cardiff University (Cardiff University, 2017). The existence of a framework that can be used to describe the digital literacy of students and staff, as well as to outline an approach for their development, was deemed as important since it could be used to establish well-defined processes to operationalise the implementation of methods for enhancing practice and achieving digital transformation. The findings indicated that digital-literacy development should be contextualised, embedded, meaningful and engaging for the learners. It was argued that it is preferable to develop the digital capabilities of staff and students within a familiar and useful to them context, rather than deliver digital-technology training discretely. At the strategic level it was particularly important to ensure the commitment of the institution to formulate relevant policies, support their implementation by adequate resourcing, and engage meaningfully with students from the outset. The recommendations of the Digidol project (Finlay and Nicholls, 2013), when generalised, were found relevant to the context of the research presented in this thesis and informed relevant research areas and design.

2.4.5.2 University of Arts London - DIAL

The University of Arts London considered an employability-focused perspective through the Digital Integration into the Arts Learning (DIAL) project (University of the Arts London, 2017). The main aim was to gain understanding of the significance of digital literacies in the professional and personal lives of staff and students. Institutional challenges included the following: provision of digital-literacy training; development of a diverse audience; the need for enhancement of the digital skills of the staff; and achievement of a large-scale institutional change in a sustainable and cost-effective way. An outcome particularly relevant to employability was the need for achieving a balanced digital environment where institutional and external, third-party, digital tools were considered in respect to their appropriateness. The support of development of the digital literacy of staff and students was also identified as a requirement.

The project findings indicated the importance of developing the students' digital literacy within a specific context of professional practice. The proposed approach suggested that students and staff collaborated through carefully managed, online digital provision and face-to-face teaching, and developed digital literacy in their discipline with respect to the local culture and norms. In order to enable approaches of this kind, digital literacy should be defined as an agile and continuous process. Whether it should be developed within or outside the curriculum was another matter for consideration. Students should be encouraged to actively participate in research and implementation of digital projects and become ambassadors to raising awareness. Implementation recommendations, pertinent to the research presented in this thesis, also included the integration of digital-literacy development into programmes of study, the establishing of staff and student training programmes, acknowledging the significance of developing digital skills, and encouraging and supporting technology-enhanced learning initiatives (Follows and Turner, 2013).

2.4.5.3 University of Bath - PriDE

An action-learning approach was adopted by the University of Bath through the Professionalism in the Digital Environment (PriDE) initiative, in response to a number of internal and external drivers that required the development of digital literacy across the institution (University of Bath, 2017). The project focused on developing digital literacies as a professional attribute for staff, and as an employability requirement for students. An important outcome of the project was the establishment of faculty-based communities of practice, involved in expressing the faculty-specific views on elements of the process, and in producing their own interpretations of the digital-literacy definitions, statements and baseline reports that reflected the ethos and culture of their disciplines. Students were encouraged to actively participate in the university life and become agents of change.

The PriDE project found that a change in management approach, where stakeholders would continuously be engaged in the processes, could be decisively successful in developing digital literacy. The process of engaging students at all levels of this change-management project was found to be effective as it enriched the project outputs, and compelled the institution to further commit in sustaining efforts for the purpose of achieving enhancement of digital literacies. Notable outputs, among others, included disciplinary-specific statements to describe digital literacies, a self-assessment tool for students, and a number of case studies. Another important benefit of this approach was the establishment of effective student partnerships that fostered innovation in taking forward the development of digital literacies within the institution (Velden and Anagnostopoulou, 2013).

2.4.5.4 Grwp Llandrillo Menai - PADDLE

In response to the changing landscape and national policy, Doodson and Eynon (2013) through the Personal Actualisation and Development through Digital Literacies in Education (PADDLE) project, aimed to enhance the digital literacies of students and staff across five Further Education (FE) colleges in Wales. The key output of the project was to produce digital-literacy frameworks customised to learners, teachers, managers and support staff. An inclusive, collaborative approach resulted in creating communities of practice for students and staff, and embedding in the curriculum digital literacy that included assessment. The project was successful in achieving a number of outcomes such as the authoring of digital-skills definitions relevant to FE, the establishing of communities of practice across partner institutions, and the recognition of good practices in the development of digital literacy in the classroom.

The PADDLE project also identified a number of challenges in developing digital competencies that were particularly relevant to the research conducted in this thesis. A significant aspect of the project was that it offered some modest evidence of successfully embedding digital literacies in the curriculum development whereby digital skills were defined, delivered and assessed. Processes that facilitated the measuring of student progress in the acquisition of digital competencies were established. It was observed that students tended to use their own technologies for learning. However, this raised questions on whether the participating institutions had the necessary infrastructure to support them successfully. The general consensus was that allowing the use of personal devices for learning was generally desired but it was important to consider how to cultivate an inclusive environment and ensure that this approach would not create barriers for the learners who did not own their own devices. Inconsistencies in the use of social media in education were identified across the participating institutions, relevant to the preferences and behaviour of the learners and the institutional policy. The need for establishing clear policies and guidance on how to best support the use of digital technologies, including social media, in a learning-encouraging way, became apparent. At the same time, these policies would safeguard the well-being of the learners in the digital domain. Furthermore, the importance of providing the staff with flexible professional-development opportunities in the use of digital technologies was emphasised.

2.4.5.5 University College London - The Digital Department

Focusing on professional services, the Digital Department project from University College London examined the changing roles of teaching administrators and their increasing importance in improving the student experience in technologically-enabled learning environments (University College London, 2017). The teaching-administrator role has steadily progressed to involve the support of learning innovations and improvements, as well as to submitting recommendations on how to implement changes. Professional-services roles have been regarded as a key in delivering the modern vision of a digitally-enabled university. Therefore, the need for developing digital literacies for the purpose of supporting the staff was identified as a professional requirement. The project implemented a number of actions to nurture the community of practitioners that foster communication, and established a professional-development programme through the Association for Learning Technology (CMALT). It also offered a number of recommendations on how to implement the findings into practice; that was on how to establish best practices in the recruitment and induction processes of new employees, on how to encourage and resource professional development and on how to establish or subscribe to professional-accreditation schemes.

A significant finding of the project was that the development needs of the professional-services staff were not always well-recognised and they risked to be thought of as underdeveloped professionals. Another key-finding was the need to adequately resource administrative teams to support academics and students. The complexity of modern educational institutions, and specialism attitudes intrinsic to the merit of this professional group, spurred detailed investigation on the changing roles and practices. In response to these challenges it was suggested that networks of professional staff should be established to enhance communication. In order to encourage participation it was suggested that contributions to the community should be recognised. Whenever possible the culture of continuous improvement in professional practice should actively be encouraged and supported through the offering of accredited training, and recognition of the benefits of a variety of generic and specialist development opportunities (Anyadi et al., 2013).

2.4.5.6 University of Reading - Digitally Ready

A targeted approach was taken by the Digitally Ready project at the University of Reading (University of Reading, 2017). The initiative aimed to address a number of challenges that included fragmentation of the approaches to developing digital literacy, a perceived difficulty of influencing change at a strategic level, increased external demand for digitally literate graduates, and the enhancement of student engagement. The project commenced with base-lining good practices and identifying gaps, raising awareness, and attracting interest in developing digital literacies further. The work was conducted through advocacy work within the institution for the integration of digital skills into student placements. A small number of developmental mini-projects adopted a student-partnership model. Students worked collaboratively with academics, conducted research, disseminated information and raised awareness around digital-literacy developments.

Key findings included the recommendation that institutions should provide students with opportunities to utilise a variety of creative digital outputs within the curriculum, or as part of extra-curricular activities. It was suggested that assessment should explicitly outline the digital-literacy criteria and development requirements, and include mechanisms for monitoring their attainment. In order to develop the digital capacity of the institution, the establishment of a formal scheme for recognition of the digital achievements of the staff was recommended. A note of caution warned against the assumption that students would readily adopt and use technologies to their full extent without guidance and support. The most significant realisation was that student engagement could be a powerful mechanism to influence institutional change and innovation. Providing seed-funding for innovation micro-projects was found to be a good method to support innovation. In cases, the positive outcomes produced were incommensurate to the costs, thus rendering the approach highly efficient. Establishing and nurturing communities of practice in support of networks was also found to have a positive impact especially when these were cross-institutional, and were formed across professional services and faculties. Investigation of the collections of case studies, digital-literacy practice guidelines and records of student stories, was found to be of significant value. The embedding of opportunities to enable the students to develop their digital literacy within the curriculum and the encouragement of student engagement were also highly recommended (Williams and Papaefthimiou, 2013).

2.4.5.7 Worchester College of Technology - WORLDE

Adopting a focused approach at digital-literacy development, the Worcestershire College Digital Literacy Enterprise (WORDLE) project at Worchester College of Technology investigated the digital capabilities of students and staff and produced evidence of good practice in planning curriculum enhancements (Worchester College of Technology, 2017). The main objectives were to design and implement blended learning within the institution, develop digital-literacy qualifications for students and teachers, author and pilot courses with teachers, and disseminate the results. Prominent outcomes and outputs included the developing of a digital-literacy framework, mapping the digital skills of students and teachers, measuring their development, and developing of a training programme aligned to their digital-literacy needs. Although the project produced only circumstantial evidence indicating that their development programme was beneficial to teachers, it resulted in establishing processes for measuring the impact of the development process. Through the monitoring progress achievement was acknowledged by issuing certificates of completion to students. The project highlighted the importance of actively involving the stakeholder group for successful implementation. Ascertaining processes to measure and monitor the development of digital-literacy outcomes were also key features of the project.

Nevertheless, it was recognised that more work was needed in statistically analysing the results and gathering the required data to measure impact. An important conclusion was that the development programme and course material should be revised so as to address teacher and student feedback. Establishment of robust quality-assurance policies and guidelines was recommended as a way of driving change and facilitating enhancement. The recommendations included the need for existence of an explicit, digital-literacy strategy, the embedding of digital-literacy skills into workshops, student inductions and the expansion of staff CPD programmes to include digital-literacy development (Robinson and Kilcoyne, 2013).

2.4.5.8 Oxford Brookes University - InStePP

Concentrating on student employability the Institutional Student E-Pioneer Partnership (InStePP) project at Oxford Brookes University was driven by a strategic commitment to develop the digital literacy of students as a graduate attribute, and enhance their employability prospects (Oxford Brookes University, 2017). Other key drivers included the re-defining of digital literacy by shifting from generic to discipline-specific definitions, and the developing of the digital literacies of staff. A partnership model was adopted where students and staff worked together to implement digital projects. These partnerships were facilitated through the establishment of processes for recruiting, developing, recognising and accrediting student participation. The developed prototype facilitated the staff/student partnerships and had a substantial influence on academic practice, particularly in relation to the development of digital literacies.

Recommendations on how to best implement such partnerships emerged. It was suggested that students should be recruited across all academic levels and offered formal academic credit for the participation. The digital projects should be defined as early as possible so as students to become able to start working on them from the outset, thus reducing attrition. The project plans should specify the objectives and milestones in a way that would accommodate for the student schedules and fit in their academic calendars. A formal mentor role should be established with the responsibility to facilitate the commissioning of project work, induct the students into the process, and help them become equal partners when working with staff. Accreditation from external parties was suggested as optional, as not essential to the success of the project, although it was recognised that it could add value. The finalised digital projects and portfolios were disseminated as broadly as possible, showcased the outputs, raised awareness and attracted further interest (Francis, 2013). From a methodological perspective, the approach of cultivating and managing student/staff partnerships as a medium used to enhance different aspects of academic life and deliver graduate attributes was of interest as an example of good practice of an implementation method.

2.4.5.9 Institute of Education - Digital Literacies as a Postgraduate Attribute

The Digital Literacies as a Postgraduate Attribute project at the Institute of Education focused their investigation on three areas of activity to develop the concept of IoE 'Open Mode' (Institute of Education, 2017). Curriculum development courses were re-designed with the aim to move away from face-to-face modes of delivery and be delivered more flexibly. The process was supported by developing staff capabilities and enhancing the understanding of teaching with pedagogies that utilised a range of delivery modes which included online distance learning and other blended approaches. Another aspect was to ensure that the technical infrastructure, and the relevant administrative processes and policies were reviewed and updated to effectively support increased numbers of students studying in a variety of blended learning modes.

Another important finding was that, in practice, approaches to change management diverge from the established theories and need to be localised within the context and constraints of the institution in order to become effective. Digital-literacy classifications and frameworks were found to be inadequate and of limited use as the individual characteristics of the actors operating within a complex environment cannot be captured with sufficient detail by abstractions, although they could be used successfully to facilitate development within certain contexts. It was suggested that digital-literacy development should be holistic and flexibly taking into account the external and internal environments and constraints (Gourlay and Oliver, 2013). From a research-design viewpoint these findings were of specific interest as they highlighted the complexities of investigating practices and acknowledged the diversity of the participants and the variety of learning and teaching environments.

2.4.5.10 University of Greenwich - Digital Literacies in Transition

A unique approach examining the digital literacies at critical moments of transition was taken at the University of Greenwich by the Digital Literacies in Transition project (Kerrigan, Coombs, Walker and Hinrichsen, 2013a). The project objectives included the establishment of a curriculum design and approval process to enhance understanding and support the integration of digital literacy by identifying technology-enabled activities in the curriculum. It also aimed at resourcing and enabling the support for the integration of technology at a holistic level, so as to develop digital literacy as a graduate attribute.

Employability and other professional-engagement characteristics were considered in relation to developing digital literacy at key transition points in the curriculum.

Digital literacy was conceptualised according to a model of critical use of technology. The framework was defined in terms of persona, meaning making, decoding, analysing, using, and problem solving (Hinrichsen and Coombs, 2014). This model offered an efficient, conceptual approach to digital literacy, based on a critical perspective. The definitions drew mainly from information and media-literacy concepts, and other cognitive capacities (e.g. analysis, decoding, meaning-making). The learners were benefited through influencing institutional policy and producing a number of resources. Digital literacy was embedded in the learning and teaching strategy and supported by the Greenwich Connect community. This work had significant impact on the research presented in the later parts of this thesis, as it has directly informed some of the concepts, ideas and approaches to the strategic implementation of digital-literacy.

2.4.5.11 University of Plymouth - SEEDPoD

A mature approach was established at the University of Plymouth in the course of the Student Experience Enhancement through Driving the Plymouth Embedding of Digital Literacies (SEEDPoD) project (Plymouth University, 2017). Previous work that base-lined systems, policies, infrastructure and data within the institution informed the design of the project. The views of the academic and professional-services staff were investigated in terms of current and prospective uses of technologies with respect to their digital literacy needs and their levels of confidence in using technologies. Interpreting the outcomes of the institutional audit, a need to review the digital infrastructure, technology-support arrangements and ways to develop digital literacy through the curriculum design was identified. The realisation that digital literacy had an impact on all staff and students, as well as on the wider institutional practices, the idea of integrating institutional strategies into the curriculum development arose. These should be monitored at the point of validation and at review stages so as to ensure the consistent use of technology across the curriculum. In practice the digital-literacy needs of a number of stakeholders was investigated to identify suitable interventions to be used for facilitating the implementation of good practices in the development of digital literacy.

Of particular interest was the conclusion in which it was stated that defining digital literacy is a complex task affected by changes in technology, and because of the subjective interpretations of the individuals. Organisational complexities and recognition of the variety of conceptualisations on developing digital literacy in diverse disciplines were identified as factors of primary interest, but it was acknowledged that these were difficult to define. In attempt to overcome these challenges the digital literacy of learners was audited to produce evidence of employability, identify their existing skills and the skills they would need to develop further. Establishing a strategic approach in embedding digital literacy supported by senior stakeholders was also deemed to be important. At the implementation level the importance of utilising pre-existing networks and communities of practice was highlighted. It was observed that this method increased the chances of success and enabled future sustainability of the initiative (McDermott, Witt and Stillwell, 2013).

2.4.6 Conclusion and the Impact of the Studies on the Research

As it was discussed in the previous sections of this chapter, the examined studies offered different approaches and insights in exploring digital literacy. Their starting points and reasons for development ranged substantially from targeted research interventions and institutional implementations to the offering of international standards and recommendations. This thesis was informed by these studies in a variety of ways aiming to establish a wider view of how digital literacy is perceived internationally, nationally and locally, within educational environments. A prominent finding of the analysis was the apparent lack of standardisation in conceptualisations, terminology, definitions and approaches. This finding does not constitute criticism on the individual research endeavours since they had different objectives and focuses but it is meant to help the identification of potential approaches in exploring current knowledge.

The conceptual framework of Eshet-Alkalai (2002; 2004) is of specific interest as it explores some of the subtle aspects of digital literacy but it is not considered as a comprehensive framework for the description of digital literacy. Some of the proposed areas are defined through cross-referencing to other areas. This fact indicates that concepts are overlapping and are not sufficiently distinct to exist independently. Examining the framework we find that it is predominantly defined by attitudes and cognitive aspects of human/machine interaction but the needed skills are neither defined nor described. Moreover, discussion on how they could associate to the referred concepts is non-existent. The experiments measured the differences of these cognitive concepts across different age groups by utilising task-based assessments. Scrutinising this method we observe that it offers a noteworthy approach in exploring digital literacy, even though the tasks are not linked to specific skills, and explanations for the existing differences, or the reasons for their development, are not provided (Eshet, 2002; Eshet-Alkalai, 2004). This is because cultivation and quantification of digital literacy through specific tasks was considered as a robust method for further exploration. Although the results do not provide sufficient details, this work contributes significantly to expanding the field of debate by associating hypermedia and socio-emotional concepts to digital literacy. The concept of defining digital literacy through quantifiable, task-based observations was intriguing and was utilised as a methodological construct.

Evaluating the DIGEULIT project (Martin and Grudziecki, 2006) against the objectives of the work-based research presented in this thesis, we find that they are naturally aligned. In particular, they share the objective of systematically incorporating digital literacies across the curriculum, share a common approach by mapping the digital elements involved in the delivery of a course, the digital competences that have to be demonstrated by the students, and identify the specific activities that would deliver the above. The provision of the digital-literacy component of the curriculum was made through problem-based teaching. This preference for inquiry-based pedagogies was also in resonance with the design of the research presented in this thesis with a key difference. The DIGEULIT project assumed that digital-literacy characteristics, such as competences, skills and attitudes, would be defined on a course-basis and would be intrinsically relevant to the course curriculum. In contrast, in this research the digital-literacy characteristics are pre-defined, albeit in a loose way and at a rather fundamental level that allows establishing the same principles to describe digital literacy, competences, skills and attitudes across any course in the curriculum in order to share a common basis. The contextualisation and targeting of specific, disciplinary qualities and skills comes at the point of delivery through customisation of the activity-based tasks.

An excellent overview of the various stages of development a teacher has to go through to become a self-sufficient expert and innovator in utilising digital technologies was summarised by the UNESCO ICT competency-standards framework (United Nations Education Scientific and Cultural Organisation, 2008b). Notably, this framework described the main characteristics of a range of teacher competencies which were considered essential in enhancing the use of ICT in education. These were presented in the form of a two-dimensional matrix where three stages of knowledge-development were defined to span the core areas of teacher professional development within educational environments. Pertinently to the objectives and the context of this thesis, these core areas for development were defined in terms of curriculum, pedagogy, technology, administration, policies and professional development. The outcomes of the UNESCO ICT competency-standards framework project are not directly applicable to the design of this work-based exploratory research as they do not describe the digital skills or competences. However, they have been useful in conceptualising the professional-development needs for teaching professionals through the use of examples of desirable outcomes in a structured way.

In pursuit of finding a suitable approach to define the skills and competencies that constitute digital literacy in higher education, the appropriateness of the EU DigComp framework (Ferrari, 2013) has been evaluated. This was because, at that time, it was the only framework that characterised the competence areas, knowledge and attitudes constituting digital literacy, and identified the required digital skills with examples of application in flexible ways which allowed for customisation of the expression of digital-literacy characteristics. This factor of flexibility allowed for its matching in the different disciplinary needs of course curricula. This complementary approach, enabled by utilisation of the framework because of its apparent granularity, is considered as advantageous when digital literacy is embedded into the curriculum-development process, as it utilises flexible technology-enhanced learning designs delivered by problem-based learning activities. Common terminology and understanding across the multiple levels of development was required to ascertain a set of principles and definitions that could be used ubiquitously in the multiple curriculum-development stages. These principles were applicable, in a generic way, to the course curricula and were used to establish processes and tools for the embedding of digital literacy in the curriculum design and delivery. Another major advantage of the DigComp approach was the generic nature and detailed definitions of the digital-literacy competences and skills that allowed for the development of tools which quantified the digital competences of learners and teachers. Quantification enabled the establishment of digital-competence indicators that were used to guide the development process and to deliver targeted interventions aligned to the specific digital-competence needs of groups and individuals.

Incidentally, the European Union Directorate General for Communications Networks Content and Technology (DG Connect) fully adopted the DigComp framework and its descriptors, thus rendering it as a common pan-European approach to developing digital literacy (European Commission, 2014a).

Particularly influential to the development of the work conducted in this thesis were a number of case studies conducted under Jisc's Digital Literacies programme (Joint Information Systems Committee, 2013). These have also been consulted to establish what constituted best practice in an area rapidly evolving during the time it took to carry out the research. The case studies informed the conceptual framework on which the research for this thesis was based on. Examining these initiatives from a broad perspective, we find that the projects were diverse since their aims, methods and staring points were diverging. However, when abstracting the concepts permeating these case studies, four common notions were identified. These are illustrated in Figure 4 below.

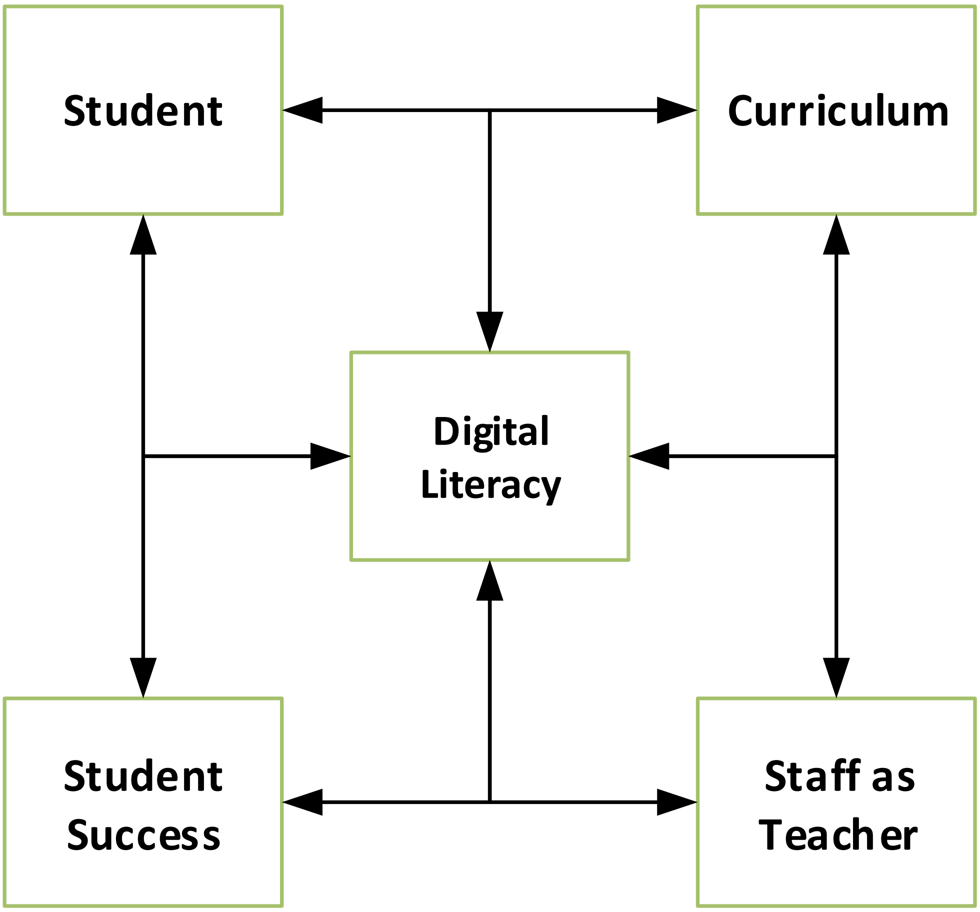


Figure 4 - Digital Literacy Development Conceptual Framework Core Areas

The four main notions influencing digital-literacy development in higher education in the UK arising from the work of the Digital Literacies programme (Joint Information Systems Committee, 2013). The two-way arrows depict the multilateral interdependencies of these concepts.

All case studies were seeking to develop, in varying degrees, the digital literacy of students in higher and further education institutions in the UK, and they were all informed by the findings of the Exeter Cascade project (Beetham, 2012; University of Exeter, 2017). The main objective, shared across all initiatives, was student success as it was conceived within the wider context of society and, in cases, expressed in terms of graduate employability (Follows and Turner, 2013; Francis, 2013; Kerrigan et al., 2013b; McDermott, Witt and Stillwell, 2013; Velden and Anagnostopoulou, 2013). Student engagement and empowerment were also deemed to be indispensable elements of digital-literacy development (Kerrigan et al., 2013b; Velden and Anagnostopoulou, 2013; Williams and Papaefthimiou, 2013). There was also broad consensus that student engagement with the formal curriculum, as well as co-curricular and extra-curricular activities, were appropriate conduits to develop digital literacy (Doodson and Eynon, 2013; Gourlay and Oliver, 2013; Follows and Turner, 2013; Francis, 2013; Kerrigan et al., 2013b; McDermott, Witt and Stillwell, 2013; Robinson and Kilcoyne, 2013; Velden and Anagnostopoulou, 2013). As a consequence of the implementation approaches that were intrinsically influenced by the organisational structures and operational modes of the contemporary educational institutions, the development of the digital literacy of academic and professional services staff was also of crucial importance (Anyadi et al., 2013; Gourlay and Oliver, 2013; Robinson and Kilcoyne, 2013; Velden and Anagnostopoulou, 2013).

Having established the core areas of digital literacy development in higher education in the UK, based on evidence of best practice in the sector, an attempt was made to theorise, model and plan its implementation into local practice. The conceptual model used in this thesis for implementation is presented in Figure 5 below. A brief analysis of the identified areas follows.

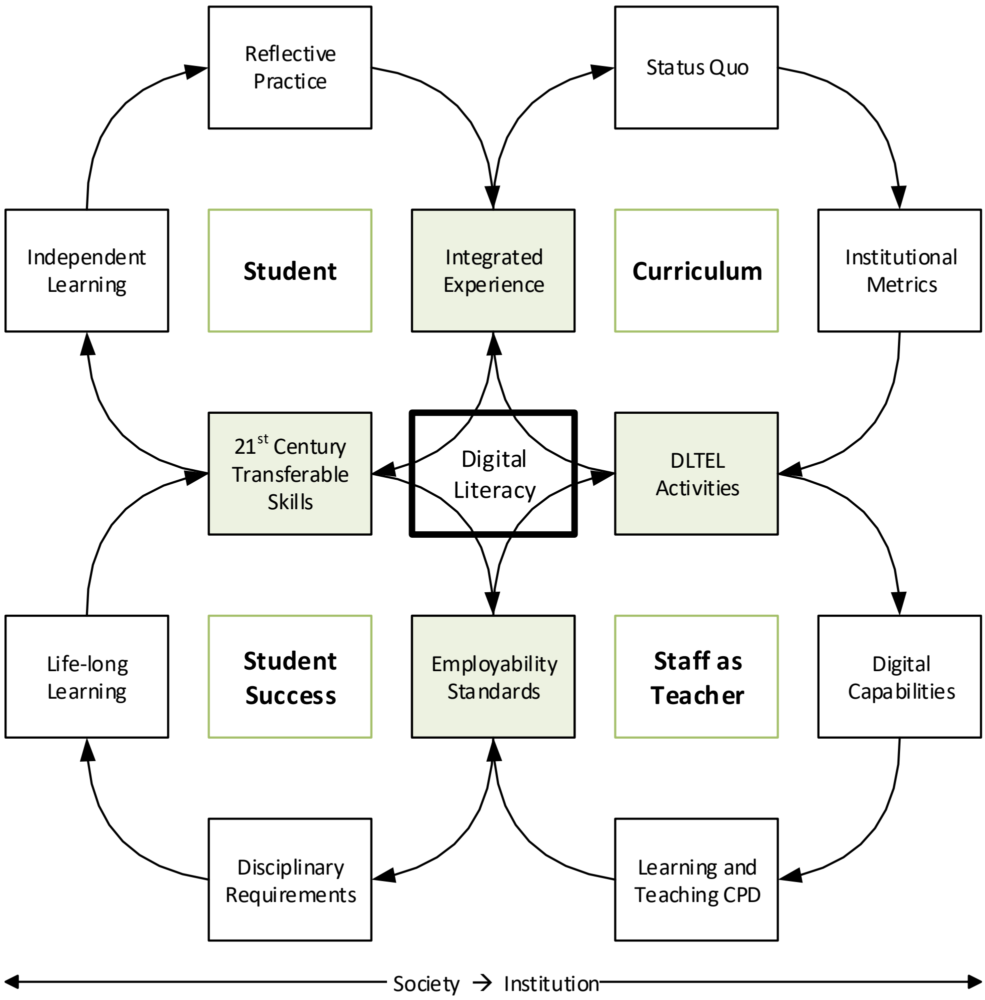


Figure 5 - Digital Literacy Development Implementation Theoretical Model Core Areas

The identified areas of interest form clusters of related concepts around the themes that arose from the work of the Digital Literacies programme (Joint Information Systems Committee, 2013). The model has been designed to depict the concepts driven by societal demands, which are external to the institution, on the left-hand side of a hypothetical vertical line drawn at the centre. Conversely, the concepts portrayed on the right-hand side of this notional line are directly owned, or at the very least, in partial control of the educational institution.

Student success was defined in terms of meeting the disciplinary and other employability requirements. In present-day societies these are not limited to academic and professional qualifications only, but also include life-long learning (Uzunboylu and Hursen, 2011; Chai et al., 2015) and other skills often described under the expansive term of 21st-century skills (Department for Education and Skills, 2003; Binkley et al., 2012; Voogt and Roblin, 2012; The Partnership for 21st Century Learning, 2015; van Laar et al., 2017; Martin, 2018). Students should become independent and reflexive learners that take ownership of their personal and professional development (Garrison and Anderson, 2003; Meyer, 2010; Scott, 2015b). These notions describe in general terms the necessary elements for the successful development of students in relation to digital literacy. As these are perceived within modern societies in the developed world. For the purpose of implementing a process to facilitate the digital-literacy development of learners within the auspices of this professional doctorate, the research work focused on the areas of curriculum enhancement and, to a lesser extent, on academic staff development. The rationale behind these decisions was backed by evidence of good practices and was based on the assumption that students experience the formal curriculum through their participation in a variety of carefully designed learning opportunities.

In practical terms the conceptual model was also informed by the work conducted at Leeds Metropolitan University for embedding digital literacy in the curriculum design (Leeds Metropolitan University, 2011). Their approach reinforced the research-design decision to deliver digital literacy as an outcome included in the curriculum-design process, rather than as an extraneous addition to the curriculum. This was a key feature of the research as it aimed to deliver digital literacy organically by enhancing and including digital literacies in the disciplinary learning designs through careful development of a number of multi-variate learning objectives. Thomson et al (2014) in his later work elaborated on how the concept of digital literacies could be successfully embedded into institutional graduate-attributes programmes.

From the design perceptive these were outlined as learning activities and modelled under the auspices of activity theory (Engesgröm, 1987; Beetham and Sharpe, 2013). In particular, the definition of Beetham and Sharpe (2007, p.29) was adopted where a learning activity was explained as a '*specific interaction of learner(s) with other people, using specific tools and resources, oriented towards specific outcomes*'. These interactions happen, and thus they are contextualised, at the intersection of the institutional environment with the wider society. Therefore, it is important to acknowledge that the student experience is highly individualistic and framed within the wider, global and local, social constructs. For example, learners have their own individual identities comprised of a variety of needs, inclinations, knowledge and motivations. Nevertheless, all these are manifested within the context of the learning environment which, in turn, operates within the wider national and global socio-economical contexts.

The local learning environment was constituted by a plethora of physical and virtual resources and tools that exhibited a variety of affordances which influenced the ways of facilitating learning. Even more important was the amalgamation of the manifested approaches and attitudes of participating agents operating within the learning environment, who were identified largely as learners, teachers and other academic-related professionals. The combination of the affordances of the environment and the attitudes of the operating agents established the local status quo. Complementing the learning-activity theory model, metrics for quantification of the pertinent elements of the activity existed. In local practice the established metrics were conventional learning outcomes defining knowledge, skills and abilities, all linked to performance indicators assessing artefacts and/or other evidence of achievement.

The implementation procedural model and associated tools presented later in this thesis utilised Biggs' (Biggs, 1996, 2004) Constructive Alignment theory and Krathwohl's (2002) revised approach to Bloom's taxonomy (1984) to embed digital literacy in the curriculum by aligning digital capabilities to learning outcomes, based on the assumption that their delivery would facilitate the cultivation of digital literacy through technology-enhanced innovations in learning, teaching and assessment. Galley's (2011) curriculum-design approach has been identified as a method for developing appropriate learning designs. Importantly, the Learning Literacies for the Digital Age (LLiDA) project recommendations by Beetham, McGill and Littlejohn (2009 cited in; Leeds Metropolitan University, 2011) have been fully embraced as a blueprint of good practice principles on pedagogic approaches, learning designs and quality assurance, and permeated the implementation process.

Learning Literacies for the Digital Age (LLiDA) Design Principles

- Design flexible learning opportunities
- Situate those learning opportunities, where possible and appropriate, in authentic contexts (workplace, community, placement)
- Design learning opportunities for highly interconnected individuals, operating in distributed networks of expertise
- Continually review how technologies are integrated into curriculum tasks
- Support learners to use their own technologies and to develop effective strategies for learning with technology
- Use assessment and feedback to encourage innovation in learners' approaches to study, rewarding exploration as a process: current assessment regimes often reward conservatism
- Support learners' developing self-efficacy and self-direction in learning, empowering them to navigate increasingly complex learning landscapes that may involve a range of digital tools such as blogs, wikis and social networking software
- Support learners' personal reflection, progression and planning, for example by engaging with e-portfolios and learning records

Figure 6 - Learning Literacies for the Digital Age (LLiDA) Design Principles

The implementation model developed in this thesis fully adopted the Learning Literacies for the Digital Age (LLiDA) Design Principles that were adapted by Beetham, McGill and Littlejohn (2009 cited in; Leeds Metropolitan University, 2011).

In this chapter a review of the literature that had significant impact on the design of this research project was attempted for the purpose of establishing the rationale for the main research-design decisions, and in order to establish how digital literacy could be conceptualised in practical terms within educational environments. It should be noted that the work presented in this thesis was conducted in parallel with some of these developments and, although the projects have been monitored from their inception, their more detailed plans and findings became available only after the data collection had been carried out. The literature presented here was directly relevant to the aims and objectives of the research and sustained considerable influence. It also set a wider context of relevant developments within the Higher Education sector in the United Kingdom at the time this research was being conducted.

Chapter 3. Methodology and the Research Design

3.1 The Research Stance

The fundamental tenet for conducting research is the examination of the types of knowledge and the establishment of the conditions that are independently required and conjointly adequate for their creation (Ichikawa and Steup, 2012). Knowledge a priori can be, defined either as non-empirical and requiring only the use of reason, or a posteriori, which means empirical, subsequent to certain sense experiences in addition to the use of reason (Baehr, 1995). Data, information and evidence are acquired through the process of reason applied to the observed reality. The nature, scope and production of knowledge relates to the concepts of truth, belief, uncertainty and justification in an area of inquiry (Klein, 1971). Defining the meaning of knowledge, the way it is acquired, the necessary preconditions and limits, and how information becomes evidence, are fundamental to every research inquiry.

Central to these contentions are the concepts of validity and research approaches that could yield a widely acceptable proof to a community of practice. Answers to questions on the nature of reality (ontology), knowledge (epistemology), appropriate approaches and procedures concerning inquiry (methodology), and appropriate tools (methods), constitute the characteristics that define a paradigm. Yet, these fields of knowledge are interlinked as ontological conjectures and form the epistemological environments that guide the methodological approaches which, in turn, are further specified by instrumentation and data-collection methods (Hitchcock and Hughes, 2002). The notion fundamental to research, underpins and permeates our understanding of the world. That is how we view it, and the meaning and purpose of our ideas about understanding (Cohen, Manion and Morrison, 2007). The prevalent views of what constitutes knowledge and the established approaches of how it can be acquired within a discipline may be generally described as a research paradigm.

3.1.1 A Note on Research Paradigms

Guba (1990, p.18) discusses paradigms in relation to their ontologies, epistemologies, and methodologies, noting that they are '*human constructions*' that fundamentally cannot be proven or disproven. Guba and Lincoln (1994, p.105) define the word paradigm as a '…

basic belief system or worldview that guides the investigator ...'. They explain that researchers, while conducting an inquiry, are constrained by their own beliefs on the nature and expressions of existence, the disposition of knowledge and approaches for acquiring it, stating that all these are often highly individualistic. Guba and Lincoln (1994, p.107) in one of their subsequent works describe paradigms in research in more general modes and assert that, '*Paradigms as Basic Belief Systems Based on Ontological, Epistemological, and Methodological Assumptions*'. Paradigms are established as a transient set of shared beliefs on how problems should be comprehended and resolved within a discipline or a community of practice. Johnson and Onwuegbuzie (2004, p.14) note, '… *by research paradigm we mean a set of beliefs, values, and assumptions that a community of researchers has in common regarding the nature and conduct of research. The beliefs include, but are not limited to, ontological beliefs, epistemological beliefs, axiological beliefs, aesthetic beliefs, and methodological beliefs. In short, as we use the term, a research paradigm refers to a research culture.*' In an attempt to generalise the formulation of what a research paradigm is, one could define it as a philosophical or theoretical framework of a discipline that describes beliefs, theories and abstractions broadly accepted by the members forming the community of the discipline.

Historically, the term research paradigm was popularised by Thomas Kuhn (1962) and, since then, it has been explored as a concept that enabled researchers to systematically create new knowledge (Morgan, 2007). Kuhn (1962, p.viii) writes on paradigms '*These I take to be universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners.*' Kuhn defines paradigms as a social phenomenon emphasising the need for an established output or outcome that arises from the application of a set of methods, commonly accepted within a discipline, which can be used to examine reality. In the pursuit of examining the research approach, Kuhn attracted criticism for his multiple interpretations of the paradigm concept. Masterman (1970), while criticising Kuhn's approach, identified twenty-one uses of the word paradigm. Kuhn (1970b, 1974) proceeded to elucidate paradigms further, examining them under a sociological lens as a group of specialist practitioners sharing common beliefs in the setting of research problems worth solving, as well as the setting of appropriate methods within a specialty. Specifically, Kuhn (1970c, p.271) attempted the re-articulation of the paradigm as a ‘*disciplinary matrix*’ where ‘*discipline*’ was defined as a specific field of inquiry, and ‘*matrix*’ as a systematic set of characteristics that merited further specification.

Because of this perceived attempt to expand the horizon on what constituted appropriate research methodology the critics of Kuhn often adopted a Popperian view of the scientific method with the experimental process at the forefront of logical, rational science, open to systematic review, therefore, self-improving (Bloor, 1971). Popper’s school of thought argued for the rational nature of science based on the premises of self-correcting openness and refutability, supposing that the experimental conditions under which a theory should be given up are honestly stated in advance. A scientist should strive to disprove theories instead of seeking evidence to support them and, by openly corresponding with the world, the consequent advancement of knowledge is inevitable (Popper, 1959, 1963, 1970). For Popper, a scientific theory must be testable under condition that science maintains its rational character and never turns into dogmatism.

Kuhn (1962) counter-argued by portraying the scientific community as inwardly looking in their commitment to fit nature into the conditions of a standard procedural model, or the paradigm. In an attempt to elucidate further Kuhn (1970b in; Wicks and Freeman, 1998, p.125) postulated ‘*... all inquiry, including science, is shaped and limited by culture, history, tradition, and perception even with science (Kuhn 1970).*’ A notable point of contention is that, although Kuhn recognises the refinement of scientific theory through use of the scientific process, he does not identify it as advancement of knowledge towards truth. For Kuhn the transition to science is marked by the deprivation of critical discourse. Kuhn’s and Popper’s theories come close enough to each other as Kuhn (1970a) himself admits. Replying to his critics on normal science and the matters arising around the debate of scientific revolutions, he proposes that these should be defined and interpreted within a sociological framework (Kuhn, 1970c). In his analysis he points out that it is the community of practitioners that needs to negotiate the accepted approaches within a discipline, make the choice of what normal science or scientific revolutions are, and not to attempt to prescribe individual behaviour.

Without analysing the intricate details of similarities and differences of the various interpretations of paradigms that fall under the domain of the philosophy of science, it would be useful to briefly examine the main characteristics of these interpretations so as to gain an insight of the wider methodological implications.

3.1.2 Ontological Assumptions

In social science, positivism is often interpreted within the strict context of life sciences research, whereby realism is adopted as the underlying ontology. The scientific methodology by experimentation and observation can extract data to test a theory, and confirm or reject the experimental hypothesis. Traditional positivist purists (Ayer, 1959; Maxwell and Delaney, 2004) view the scientific process as the means to uncover the universal laws governing human behaviour (Beck, 1979). The spectrum of traditional ontological views ranges from the objective realism advocating the existence of an objective reality that can become known (Lincoln, 2010) and expressed by the positivist epistemologies, to its ostensible opposite, the subjective nominalism that rejects the existence of universal truths (Rodriguez-Pereyra, 2015) and perceives the world and its meaning as constructed by the experiences of humans, as these are situated within specific contexts expressed by the anti-positivist epistemologies (Beck, 1979).

Positivism under realism, as Barr Greenfield (1974, p.1) notes, is based on the assumption that, '*the world exists and is knowable as it really is*', and that by following the scientific process conducted on the basis of concepts, abstractions and ultimately on theories, the researcher investigates social reality by quantifying the observable phenomena. On the other end of the ontological spectrum of social science, researchers adopt idealism. Barr Greenfield (1974, p.4) notes that '*the world exists but different people construe it in very different ways*'. It is assumed that humans see the world, or physical reality, as it is perceived by the individual, and acknowledge multiple interpretations of reality. Under idealism, the approach of the inquiry is based on the assumption that humans use sets of meanings to explain their behaviour and construct their own reality.

The methodological implications of the scientific method, implicitly rejecting the other modes of qualitative enquiry as non-science, speculative, or biased, have been the third characteristic within the paradigm debate (Guba, 1990). An alternative to the positivist doctrine came in the form of naturalistic inquiry, a term defined by the constructivist, interpretivist, critical theorist, post-positivist and participatory research paradigms (Lincoln and Guba, 1985; Lincoln, 1990; Guba and Lincoln, 1994; Lincoln, Lynham and Guba, 2011). Their analyses were concentrating on the ontological, epistemological and methodological affordances and, as a result, the emerging paradigms were perceived to be antagonistic to positivism.

Comparing and contrasting the arguments and assumptions of the quantitative and qualitative paradigms by holding a purist stance, implicitly sets these paradigms in conflict (Campbell and Stanley, 1963; Lincoln and Guba, 1985; Guba and Lincoln, 1994; Lincoln, 2010). Positivism, due to the underlying ontological assumptions, manifests itself as an opposing force between describing (realism) where researchers, using scientific methods, observe reality from a neutral and unbiased perspective, and prescribing (idealism) where the researcher presents his ideas by concepts, generalisations and wider acknowledgements that lead to social ideals. More recently, as Johnson and Onwuegbuzie (2004) note, consensus has been achieved in a number of the previously contested philosophical arguments (Reichardt and Rallis, 1994; Phillips and Burbules, 2000) among the qualitative and quantitative researchers.

In summary, these are:

a) the subjectivity of reasoning,
b) the intrinsic preconceptions in observation,
c) the un-deterministic nature of theorising from data,
d) the existence of ancillary assumptions when formulating hypothesis,
e) the inherent chance of variation of interpretation,
f) the inevitability of presumptions within communities of practice, and
g) the irrevocable interaction of the researcher's beliefs when observing and interpreting.

Acknowledging that contemporary social-science experimentation is mostly post-positivist (Phillips and Burbules, 2000) rather than positivist in nature (Yu, 2003) and, rejecting the incompatibility thesis (Howe, 1988) that dictates ontological and methodological purity, a pragmatist ontological alternative was embraced due to the work-based nature of the conducted research.

3.1.3 A Pragmatist Perspective to Explore Professional Practice

While operating within a large higher education organisation as a professional practitioner, a need for developing the digital literacies of students and staff was identified. This work-based research adopted Kuhn's interpretation of a paradigm that is defined as a scheme of commonly accepted values and principles of the community of intellectuals' practising in an area. The ontological and epistemological implications of the more traditional paradigms were deemed to be constrained by the inquiry norms founded on ontological assumptions that were in turn rooted in the philosophical debate. Rejecting the paradigmatic absolutes, the research in this thesis was influenced by the views of Dewey, James and Mead, putting the emphasis on intelligent action by deliberation of multiple competing lines of action, and with consideration of workability (Biesta and Burbules, 2004; Morgan, 2007; Mertens, 2009; Morgan, 2013; Biesta, 2015). The legitimisation of pragmatism, as a valid background to research, is based on achieving consensus on what constitutes acceptable conduct, background for justification and outcomes of action within a community of practice. Pertinently, Marcuse (2010, p.259) notes that ensuing Dewey's theses on logical forms as the rudimentary principles of the inquiry they '*…arise from the research itself, remain referred to the sense of the research, and — just as much as their "subject-matter" — alter them-selves with the research…*'. In this light the researcher can discover empirical evidence to support beliefs by performing investigative interventions in the field of study, and by observing the results of these actions. The theory under investigation is the apparatus used to accomplish an outcome, or to enable comprehension by action (James, 1907). James and Dewey understand theories and concepts as instruments that are closely related to outcomes, and their performance is evaluated by their successful delivery.

The research was carried out from an ontological position characterised by Dewey's (1938) pragmatism and focused on what was applicable in reality, rather than attempted to define a worldview of what reality was, and how it could be studied to solve real human problems (Rorty, 1989; Stich, 1993). Experience, as it is interpreted by the traditional pragmatist view, is arguably a mode of empiricism that conceives the individual as a passive receptor of streams of sensory inputs, representing the given as it has been perceived. Pragmatists such as Pierce, James and Dewey recognised that experience based on sense inputs can only be considered as a perception if and when it is interpreted by cognition. This view was significantly different from the pragmatist views of the earlier philosophers (Smith, 1978).

3.1.4 Methodological Assumptions

Attempts to establish the pragmatist doctrine as the ontology for social science research are by no means novel and have been discussed in the literature (Tashakkori and Teddlie, 1998; Maxcy, 2003; Watson, 2010; Morgan, 2013, 2014). When adopting a pragmatist view, research designs should first and foremost focus on the inquiry to facilitate the answering of the research questions (Tashakkori and Teddlie, 1998; Johnson and Onwuegbuzie, 2004). A number of authors advocate pragmatism as a potential paradigm for mixed-methods research (Creswell, Plano-Clark, Gutmann and Hanson, 2003; Johnson and Onwuegbuzie, 2004; Morgan, 2007; Denscombe, 2008; Feilzer, 2010; Tashakkori and Teddlie, 2010; Anderson and Shattuck, 2012; Hall, 2013; Prieto, Dimitriadis, Asensio-Pérez and Looi, 2015). Johnson, Onwuegbuzie and Turner (2007, p.123) define mixed methods as '... *the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the purposes of breadth and depth of understanding and collaboration.*' However, one needs to be careful in assuming that a pragmatist stance can be readily exalted to fulfil the role of a new research paradigm (Gorard and Taylor, 2004; Greene, 2008; Denzin and Lincoln, 2011). Pragmatism, as a philosophical approach, should not be used indiscriminately to form the ontological basis for justifying a mixed-methods research. It could also be used to critically analyse epistemological and methodological implications (Biesta, 2010).

Biesta (2010) identifies seven layers that could assist in exploring mixed-method approaches conducted under a pragmatist lens: a) data, b) methods, c) design, d) epistemology, e) ontology, f) purpose and g) practical role. An attempt to apply this analytical framework to this research and examine the implications of the mixed-methods approach starting from the final layer and moving in reverse order, follows. The decision to reverse the order of analysis was made with purpose to reflect the circumstances under which this research has taken place and, in particular, to highlight the fact that the overarching purpose was to innovate and improve professional practice. The purpose of the research was to provide the theoretical underpinnings (model) and practical methods (processes) used to achieve this transformation in an organised way stemming from evidence. The approach could be characterised as exploratory, rather than explanatory. This methodological decision was implicitly associated to the ontological assumptions of the researcher which, if broadly considered, could be either deterministic or interpretative and, as a result, examine social phenomena in respect to causality, or seek their meaning. The research is positioned within the interpretative paradigm aiming to develop a model and processes for the purpose of changing practice and, in this preliminary stage, it could not seek causality but only interpret the apparent phenomena arising from the lived experiences of the participants.

In turn, epistemological questions on what it means to know, and whether what is known is objective or subjective, arose. Considering this profound epistemological question in respect to the context of this research, a subjective stance was assumed acknowledging the impossibility of mixing epistemologies. Equally, the mixing of methods was not perceived to be the same as the mixing of epistemologies and certainly it did not assume or imply the mixing of paradigms. The chosen mixed-method methodological approach was considered to be the optimum one for exploring the research questions effectively due to the complexities of the educational environment and the objectives of this work-based research which were transformative in nature. The richness of information that resulted from both qualitative and quantitative data was deemed to be important to the exploratory process. A primarily naturalistic approach, including experimental elements, was employed at the conceptual level of the research design. The research was conducted as a series of concurrent, nested case-study designs (Creswell et al., 2003), as different features of the model, tools and associated processes under development were explored. Although the two types of methods and research designs are often considered to be in conflict, in this research qualitative and quantitative methods have been used complementarily to investigate and model different aspects of a multifaceted phenomenon.

Important questions were raised on how the results could be interpreted for the advancement of knowledge in case one wanted to explore the consequences of interventions upon a phenomenon, while they were simultaneously aiming at observing the phenomenon itself. In the light of pragmatism this distinction is illusory as action is one of its defining and indispensable tenets. Thus, the research would become by definition interventionalistic because the act of observation itself can affect the system under examination. Similarly the mixing of methods, resulting in both numerical and textual data under a pragmatist stance, was not intrinsically problematic, since both could be considered as two different forms of evidence. The use of the mixed-methods approach in the research design was chosen with the aim to allow for flexibility in the collection of data and answer the research questions within a dynamic work-based environment.

However, when analysing the data, the researcher was cognisant of the fact that the mixing of methods would pose unique challenges in interpreting the results and in the deduction of conclusions. For these reasons the research could not aim at producing and testing theory in the conventional sense of other research inquiries but, as a work-place study, it aimed at developing and evaluating a model and processes that would transform professional practice. A follow-up explanatory study of the application of the model and processes would produce data for the evaluation of the theoretical assumptions and practical implications of the designs. However, this was deemed to be out of scope within the time frame of this preliminary, exploratory, modelling phase.

3.2.1 An Interactive Mixed Methods Research Model

The traditional pragmatist models of conducting mixed-method research call for a direct association of the research questions to the methodology. But this is merely a result of the tendency of researchers to document their work under various preconceived classifications or taxonomies that examine how the quantitative and qualitative approaches are combined, rather than focus their attention on describing how the study is conducted (Maxwell and Loomis, 2003). The realisation of existence of such subtle differences between planning a methodological approach in the abstract and employing the research methods in practice when conducting an inquiry, is what Kaplan (1973, p.8) identified and termed as '*logic-in-use*' and '*reconstructed logic*' when he examined the use of logic in science. Reflecting on these subtle differences and their implications on methodological design, the interactive design model proposed by Maxwell (1996) was considered as suitable for conceptualising multiple-methods research conducted within dynamic environments.

Another aspect that substantively affected the choice of the research design was the fact that this work-based study was carried out within the confines of an operational organisation aiming to develop a transformation model and processes, and gather evidence in support of achieving change. This fact intrinsically limited the scope and scale of the study as these transformation tools had to be developed and tested to a sufficient extent before the organisation could sanction their wider use and fully assess their value. Moreover, due to the fluidity of the ever-changing environment in which the research was conducted, the design had to be flexible so that it could be shaped alongside the work-based developments. It is important to note that this resulted in the research being conducted in a number of distinct, although related, phases through a number of interventions not following a strictly predetermined design. An abstracted representation of the research design is shown in Figure 7 below.

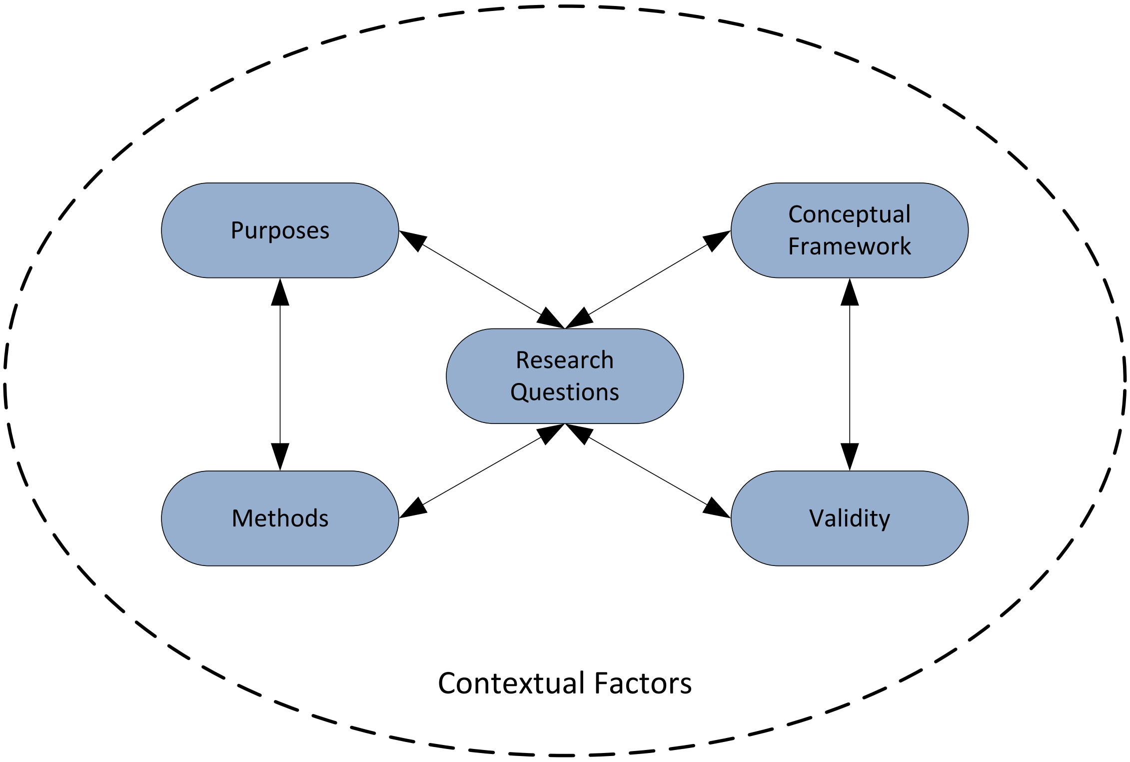


Figure 7 - The Interactive Design

The interactive research design adopted in this thesis (adapted from Maxwell and Loomis, 2003, p.246). Maxwell (1996, pp.4–5) defined the 5 central elements of the research design model as: a) purposes, b) conceptual framework, c) research questions, d) methods and e) validity. It should be noted that this model operates interactively and it suitable for use within dynamic environments. The research purposes, questions and methods are in flux and inform the conceptual framework.

Considering the elements of this interactive model we find that they are not intrinsically different from what is often discussed in the research design literature. What is different is that this model is dynamic and its parts are interdependent and interactive. The research questions, although in the limelight of the design process, they are not necessarily the starting point, or the leading factor. They can influence and be influenced holistically by any of the other elements that interact within a fluctuating environment. The five defining aspects can be affected by a variety of external, contextual factors, such as the environmental settings, ethical considerations, personal goals, existing theories, personal experiences, familiarity with a paradigm, personal preferences of research methods, the researcher's skills and the emerging data. Within the context of this thesis the research model was framed and understood as a practice-based inquiry that was to bring theory into practice.

The research was conducted from an insider's perspective with the investigator acting as an integral part of the community aiming to transform and improve practice (Sagor, 2000; Koshy, Koshy and Waterman, 2010). It followed a tripartite model for exploratory research that defined the field of inquiry and the boundaries for action, reflected on the findings while refining further actions accordingly, and culminated into reflexive practice (Robertson, 2000). Reflexivity was a key concept when conducting the research, as the researcher and the participants were part of the same community of practice. Kolb's (1984) experiential cycle was utilised as an implementation approach with reflective observations guiding abstractions of concepts that informed active experimentations which ultimately led to concrete changes in practice. Concurring with Maxwell and Loomis (2003) this interactive research model was advantageous because it allowed for an authentic approach to defining the research design which represented realistically the way the research was conducted in practice. It also allowed for a closer examination of the mutual interactions of the individual components and the effects of integrating the various methods employed within a dynamic environment.

3.2 The Research Methodology

The main aim of the research was to develop the digital capabilities of learners and teachers within the faculty of Health, Social Care and Education in a Higher Education institution in the United Kingdom. The primary incentives for this research project have been identified at global (institutional), local (faculty) and individual (personal) levels. Global incentives were driven by the ongoing digitisation of modern societies and the need for the corresponding modernisation of higher education. Locally a need for further development of the digital capabilities of staff has been explicitly identified. Academic and administrative staff increasingly have to use a variety of digital technologies in their respective professional roles to successfully fulfil their duties. At a personal level the researcher, as a professional practitioner responsible for the introduction of these new technologies and for providing training and support, had a principal interest in optimising technology training to achieve measurable change in practice.

It is important to note that at the time of commencing the research the external drivers were less pronounced and, as a result, the local incentives were not explicitly articulated. The environment changed significantly, nationally and internationally, during the time of carrying out the research, with the external enticements being overtly articulated by the Government through the relevant quality assurance agencies. This fact resulted in an explicit identification of the need for conducting this research work at the institutional level (Quality Assurance Agency, 2014; House of Lords, 2015). The shift in the external environment had a direct impact on the research design which was initially constrained by the need for balancing the requirements with the quality assurance restrictions imposed within a fully operational institution, and with the relative influence the researcher could exert.

For these reasons, the research was originally designed to be as unobtrusive as possible while, at the same time, it attempted to establish evidence about potential benefits. The initial research objective aimed to investigate how students, academics and academic-related professionals perceived digital literacy within healthcare education and reveal any digital-literacy attributes that could be considered as specific to healthcare education. As a result of the emergent institutional support the project grew organically from a small-scale investigation to an extended research project that aimed at creating an evidence-based model and introduce processes that could measurably enhance practice. A latent overarching research objective was to investigate how the institution could ensure that digital literacy would be embedded in the curriculum. This incremental approach to research design was due to the work-based nature of the research which developed, over time, to a holistic bounded case-study built on the pragmatist worldview. It was conducted within a dynamic environment in distinct but related phases comprised of a number of interventions.

The overarching case study can be interpreted by Yin's definition (2012, p.4) as '*An empirical inquiry about a contemporary phenomenon (e.g., a "case"), set within its real-worldcontext – especially when the boundaries between phenomenon and context are not clearly evident.*' The essence of case-study research is the examination of the specific circumstances and intricate parameters that constitute the case under investigation. Merriam (1988, p.21) discusses case studies by focusing on the outcomes of the research and defines them as '… *an intensive, holistic description and analysis of a single instance* …'. One of the major advantages of case-study research is that it enables the meticulous study of a case by examining the contextual and other associated parameters holistically. Stake (2008), although much less regimented in his approach, concurs with Yin noting that the focus of the case-study is demarcated by the objectives of the investigation in question and not by the methods used. From a macroscopic viewpoint a case study aims to demonstrate broader principles by examining a particular situation of a closed system such as a class, a school or a community (Adelman, Jenkins and Kemmis, 1976). The main stages of the overall case-study constituting the sum-total of the research are depicted in Figure 8.

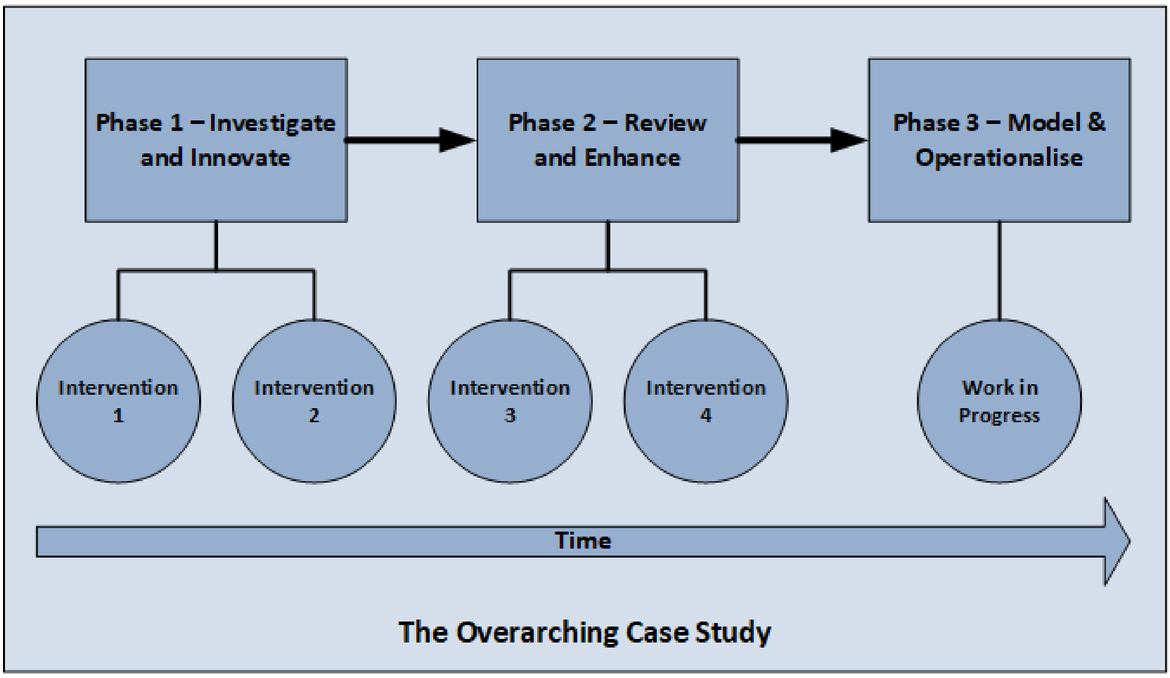


Figure 8 - The Main Stages of the Case Study

The overall case study was constituted of three main stages illustrated here as: Phase 1 – Investigate and Innovate, Phase 2 – Review and Enhance and Phase 3 – Model and Operationalise. The first two stages (Phase 1 & 2) are constituted from self-contained sub-cases that investigated local practice and are depicted here as interventions (Interventions 1-4).

In this research the system in question is the faculty of Health, Social Care and Education of a higher education institution in the United Kingdom. Case studies and interpretative methodologies are compatible and characterised by investigation of the perceptions of participants in a natural**,** dynamic environment or situation (Bryman, 2012). A case study can be described as a scrutinised account of events relevant to temporal and situated instances with the focus on the participants' perceptions, experiences and interpretations of events that were relevant to experimenting with developing digital literacy (Hitchcock and Hughes, 2002). This elucidation reverberates with Yin's (2012, p.6) characterisation of a case within case study research, as '… *a bounded entity (a person, organization, behavioural condition, event, or other social phenomenon), but the boundary between the case and its contextual conditions—in both spatial and temporal dimensions—may be blurred …*'. It also resonates with Yin's (2014) characterisation of case studies as exploratory and interpretative. Overall the research can be characterised as exploratory because it developed a conceptual model and processes for embedding digital literacies into curriculum development and can be described as interpretative because it employs inductive methods deriving from evidence, based on the views of students and academic professionals, instead of from policies.

Ascertaining the sum of the research according to Yin's (2012, pp.6–7) interpretation of a case as the '*unit of analysis*', the study could also be characterised as a '*holistic*' design with embedded '*sub-cases*' emerging in the form of the self-contained interventions illustrated in Figure 8. This approach helps to contextualise the interventions as individual parts that achieve specific research goals within the wider case-study methodological framework and work complementary to each other. The advantages of examining the sum total of this research as an overarching case-study are multi fold. This approach allowed the investigation to uncover the richness of detail contextualised within the boundaries of the various interventions rooted in the local reality and embedded in the social context of the environment under examination. The research was conducted within the everyday institutional environment in a straightforward, natural manner, free from preconceptions of elaborate organisation-behaviour frameworks. The main aim was to uncover what worked in practice by recording the views of the students and academics when participating in a number of purposeful interventions. These observations initially produced rich descriptive data that have been used to guide further action and informed the subsequent data collection.

However, this emergent case-study approach, built on a number of discreet interventions, also presented some challenges. A main concern was the inherent difficulty to generalise from the intervention results, as these were temporal, environmental and contextual. As a result, confirmation and verification were only partial since the interventions were not easily repeatable and, in any case, significant elements of interpretation were running the risk of being thought of as having the potential to introduce bias. They were also prone to be selective, personal and subjective, since the researcher was embedded in the observations and intrinsically involved in the production of the research data and its interpretation. For these reasons extreme care was taken to limit these effects through the utilisation of a systematic approach supported by the establishment of robust research protocols.

3.3 The Research Design

The research design is illustrated in Figure 9 identified in five layers (Actions, Tools, Methods, Data and Publications). The first three describe aspects of the various steps and the last two indicate outputs. The various elements of the research-design have been labelled and numbered to allow easier referencing (e.g. [ACTION_01], [TOOL_01], [DATA_01] etc.). Actions are denoted in chronological order and identify the sequential order of each action. Tools identify the use of research instruments such as interview schedules, questionnaires, frameworks and assessment tools. Methods that identify the type of data collected from the associated tool indicated as qualitative or quantitative, alongside their relative power, were measured in the relevant quantity (e.g. number of participants or word counts). Data indicate the collection of data sets, and publications identify any relevant articles published prior to this thesis.

An important point to note is that the choice for the formatting of this thesis was affected by the dynamic and interactive research design that was appropriate for this type of work-based research. The next two chapters present the research in the way it was conducted as a sequence of activities, rather than following a more traditional structure. The methods, data, results, analysis and conclusions were presented separately for each phase. The choice of the presentation formatting was deliberate as it more accurately depicts how this work-based research was conducted, and it helps to explain the rationale of why certain decisions have been made[1].

[1] The reader is advised to read the thesis and follow its development by regularly consulting Figure 9.

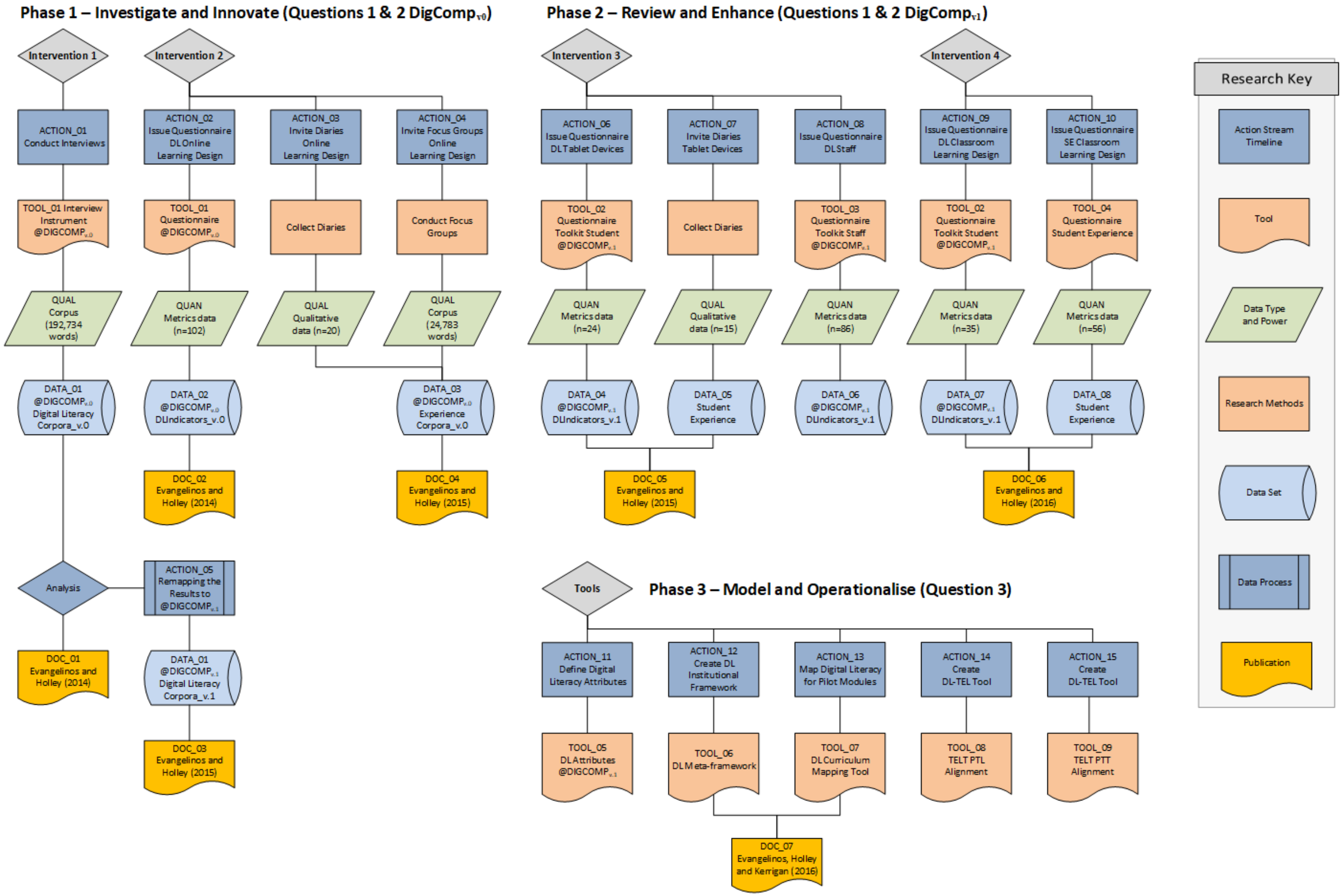


Figure 9 - The Research Design

The linear approach to research, arising within a pragmatist worldview where the research questions dictate the design, was applicable to the initial stage of the inquiry (intervention 1). The research proceeded by evaluating the experience of students undertaking online activities intended to enhance their digital capabilities by embedding digital literacies into activity-based learning designs (intervention 2). This model and related tools for embedding digital literacy into curriculum development were based on the initial version of the DigComp_{v0} framework (Janssen and Stoyanov, 2012) which was at that time under development. The published DigComp_{v1} framework (Ferrari, 2013) was in a revised form and, as a result, the bespoke tools created in support of the curriculum-development model had to be updated and re-evaluated. In order to assess the applicability of the updated tools, the student experience in using mobile devices for the assessment of clinical practice was documented alongside a quantitative self-assessment of digital capabilities of the students and staff (intervention 3). The updated tools were further put into practice in the classroom by utilisation of the curriculum-design model that had previously been explored (intervention 4).

The inquiry was conducted as a series of actions grouped in four interventions that constituted the three research phases. These were:

a) Phase 1 – Investigate and Innovate (Intervention 1 including Actions 1 & 5 and Intervention 2 including Actions 2 - 4),

b) Phase 2 – Review and Enhance (Intervention 3 including Actions 6 - 8 and Intervention 4 including Actions 9 & 10)

c) Phase 3 – Model and Operationalise (Authoring design tools to support the implementation process Actions 11 - 15).

In phase 1 an investigation was carried out on the flexible applicability of the EU DigComp framework as a generic digital-literacy framework to evaluate whether it could be used to support student learning in university healthcare settings. During this initial investigative stage a sub-question on whether any attributes of digital literacy were specific to healthcare education arose naturally. The DigComp framework was chosen as it defined digital literacy and described its multi-dimensional components in generic terms but with sufficient detail, and illustrated their application by examples. This was the first action in the research design and it was of crucial importance for two reasons: a) the framework had to be validated against its appropriateness and suitability to describe digital literacy in a health-education environment by the main stakeholders and b) digital literacy is a generic high-level concept that is difficult to define without significant elaboration of the specifics of the context. For this reason, it was important to establish a common frame of reference on what digital literacy was before engaging the non-expert stakeholders. This was achieved by creating a self-assessment questionnaire (Evangelinos and Holley, 2014b) based on the initial results of the DigComp$_{v0}$ framework that was used as a tool to baseline the digital-literacy characteristics of the participants, and as an instrument for conducting the semi-structured interviews that validated the framework (Evangelinos and Holley, 2014a, 2015a). This research phase was completed by experimenting through the application of a technology-enhanced learning-design approach that aimed to enhance the digital literacy of students through embedding online technology-enhanced learning activities into the curriculum (Evangelinos and Holley, 2015b).

Phase 2 was constituted of the re-working of the digital literacy self-assessment questionnaire to reflect the structure of the published version of the DigComp$_{v1}$ framework (Ferrari, 2013) and utilise a new scenario-based approach implemented in the self-assessment tool in an attempt to produce more accurate results. This updated questionnaire was used, alongside a survey of the student experience on using digital technologies, to assess the digital literacy of students when asked to use tablet devices for the assessment of their clinical competences in practice (Evangelinos and Holley, 2016a). A staff-specific version of the questionnaire, developed along the same lines merged with additional questions for the assessment of their professional digital practices, was administered to academic staff. It aimed at investigating the potentials and limits of measuring staff digital capabilities. This research phase concluded with the assessment of the digital literacies and experiences of students when taught through the utilisation of a technology-enhanced learning design that was delivered through the use of digital technologies in the classroom. Phase 2 implemented the same research and learning-design methods used previously, but in contrast to Phase 1 it utilised the evolved taxonomies of DigComp$_{v1}$.

Finally, in Phase 3 the outcomes of the two previous phases, after having been assessed, generalised and theorised, were amalgamated to a model for embedding digital literacies into curriculum development. Following a pragmatic approach, processes to facilitate the transition from the established status quo to a new model for curriculum development and delivery have been put in place. Phase 3 commenced by establishing digital literacy as a generic attribute that had to be acquired by students and it was defined by a number of high-level descriptors that were further broken down to sets of digital competences. The development of this meta-framework was based on the $DigComp_{v1}$ framework (Ferrari, 2013) and work from the Joint Information Systems Committee (JISC) (Kerrigan et al., 2013a; Hinrichsen and Coombs, 2014; Joint Information Systems Committee (JISC), 2015). A tool for assessing curriculum-mapping (Kerrigan and Evangelinos, 2015) has been developed to map the digital-literacy characteristics of the established curriculum and issue online digital-literacy badges according to the definitions of the bespoke digital-literacy online badge framework (Kerrigan and Evangelinos, 2016b). A model based on technology-enhanced learning designs, the associated quality-enhancement processes and a comprehensive training and development programme have also been proposed to facilitate the staged curriculum (re)-development that aimed at embedding digital literacies as an attribute of all the curriculum offerings.

3.4 The Research Ethics

Formal ethical approval for conducting the research was obtained (number: 12/091) from the faculty research ethics panel on 24/09/2013 and was valid for three years (See Appendix - Ethics Approval). The approval was granted on the basis of adhering to the institutional policy and code of practice for research with human participants (Anglia Ruskin University, 2011). The participants have been informed on all pertinent ethical considerations including the established measures for protecting the participants' anonymity and confidentiality, their right to withdraw from the study, ownership of the data, right to publish the results, the option for anonymous participation and the importance of acquiring their informed consent (Rabbitt, 2003).

The Economic and Social Research Council (2012, 2017) set six key-principles for ethical research to ensure integrity, quality and transparency, the provision of full information to research staff and participants about the purpose, methods and intended purposes and the risks involved, while securing confidentiality of information supplied by research participants, the anonymity of respondents, their voluntary participation, avoidance of harming the research participants and the independence of the researcher. Moreover, the participants were explained explicitly all they needed to know about any existing conflicts of interest or partiality that might have arisen due to the objectives of the research.

Principles were underpinning the guidelines of all educational research such as stress, respect for the individual, knowledge, democratic values, quality and academic freedom. These guidelines, among other, include: the need for openness and disclosure, the right to withdraw, voluntary informed consent, provision of incentives, privacy and prevention of harm arising from participation in the research (British Educational Research Association, 2011). The researcher has strictly followed and complied with all the guidelines dictated by the Higher Education institution where the research took place (Anglia Ruskin University, 2011), ESRC (Economic and Social Research Council (ESRC), 2012, 2017) and BERA (British Educational Research Association, 2011), which composed a comprehensive framework of ethical issues in educational research.

ESRC Principles	Evidence
Research should aim to maximise benefit for individuals and society and minimise risk and harm	Voluntary informed consent was acquired from all participants for all data
The rights and dignity of individuals and groups should be respected	The research was conducted ethically and safeguarded the welfare of the participants
Wherever possible, participation should be voluntary and appropriately informed	The main research aim was to improve the digital literacies of students and staff and record their experiences
Research should be conducted with integrity and transparency	The research protocol included the unconditional right to withdraw (the process was triggered once as one participant decided to withdraw)
Lines of responsibility and accountability should be clearly defined	All the necessary permissions, ethical and managerial, were acquired
Independence of research should be maintained and where conflicts of interest cannot be avoided they should be made explicit	There were no conflicts of interest

Table 3 - The Economic and Social Research Council (ESRC) Ethics Principles and Evidence

The Economic and Social Research Council (ESRC) Ethics principles and evidence of implementation into practice (Economic and Social Research Council (ESRC), 2012, 2017).

BERA Guidelines	Evidence
Voluntary Informed Consent	Voluntary informed consent was acquired from all participants for all data
Openness and Disclosure	The research protocol was communicated prior to the research and participants were invited to seek clarifications
Right to Withdraw	The research protocol included the unconditional right to withdraw (the process was triggered once as one participant decided to withdraw)
Children, Vulnerable Young People and Vulnerable Adults	There were no children or other vulnerable young or adult participants. This was confirmed by checking the participant's details via a 3rd party within the institution
Incentives	Incentives were not offered
Detriment Arising from Participation in Research	There was no significant risk of detriment due to participating in this research. Interviews were audio recorded (with consent), transcribed and analysed and the participants debriefed
Privacy	All research data was anonymised and privacy safeguarded throughout the analysis stage
Disclosure	No conflicts of interest to declare

Table 4 - The British Educational Research Association Ethics Guidelines and Evidence

The British Educational Research Association Ethics Guidelines and Evidence of implementation into practice (British Educational Research Association, 2011).

3.4.1 Insider Research

From a professional practitioner's standpoint, research in the workplace offers unique opportunities to observe and interact with the organisation in a professional capacity, and research on applied practices for the advancement of knowledge. When investigating organisational practice, the moral principles governing the objectives and the methods applied to the inquiry are inextricably associated. The discipline of analytically examining the philosophy of these moral principles is known as ethics (Fieser, 2016). These moral principles relate to the epistemological choices that delineate the nature, foundations and boundaries of knowledge and, through the use of research frameworks, are applied for the advancement of human interests.

The issue of obtaining access (Knowles, 2008) has been discussed with the senior faculty gatekeepers and the project was given permission to proceed with the main investigator acting as an inside researcher. The research questions were congruent with the benefits of the institution and with contribution to knowledge in general (Trowler, 2014). With regard to the issue of familiarity the researcher, as an insider, undoubtedly had a better initial understanding of the imperceptible associations between occurrences of events and could better evaluate the implications (Mercer, 2007). The research has already affected university policy and stands good chances to further enhance local practice. The disadvantages of conducting research as an insider were mitigated by ensuring the integrity and the fair representation of the data, and minimising bias while actively trying to avoid negative issues of conflict that could arise from the duality of the research investigator's role as a professional. Agreement from the faculty gatekeepers was acquired that the data would only be used to model professional practice and not as evidence of performance. Informed voluntary consent to participation, and processing of the data anonymously, safeguarded against any form of coercion the participants might be feeling to take part in the research. The raw datasets have not been made available to anyone outside the supervisory team at any point but the anonymized group reports have been used to establish an overall group benchmark and inform policy.

Nevertheless, power differentials sometimes inadvertently arise from the roles of the researcher and the participants (Mercer, 2007) and may exclude preformed expectations of alignment resulting in changes in the participants' responses, interview bias, or even reinforce the tendency of taking things for granted. This point was particularly relevant in conducting the staff interviews, as colleagues may have felt intimidated in being interviewed by a co-worker. As a counter-measure the questions were kept open and did not focus strictly on the workplace as the research area. Many examples of technology-use were discussed in terms of everyday life or in the context of personal use. Interestingly, most staff interviewees offered examples of how they used technologies in the workplace out of their own volition. Challenging of assumptions and articulation of shared norms, as well as conscious or unconscious distortion of provided information were also minimised by continuous evaluation and validation of the results by seeking confirmation of the initial interpretations during the interview process and conscious efforts to maintain a neutral standpoint.

3.4.2 The Research Protocol

The main purpose of the research was to develop the digital literacy of students and staff within the Faculty of Health, Social Care and Education at a higher education institution in the UK. The investigation focused on the views and experiences of students and staff to acquire a more holistic view of the digital capabilities and implications in education that were brought about by the availability of new technologies. An examination of how digital literacy was understood by students, academics and academic-related staff was conducted to investigate the emergent themes and digital-literacy characteristics within a healthcare education environment. The results defined a basis for further exploring how the institution could best facilitate the development of the relevant qualities and skills needed from graduates by nurturing digital literacies within the educational provision of the curriculum. Ultimately, the work informed the strategic planning and supported the formulation of evidence-based policy on how to best develop digital literacies within the curriculum delivery.

The data collection was carried out during phase 1 (intervention 1 and 2) and phase 2 (intervention 3 and 4). The research design produced eight data sets specifically, four qualitative and four quantitative. Table 5 summarises the tools applied and the corresponding data outputs and types, as well as the anonymisation methods. Informed consent has been acquired from all of the participants either in writing or electronically. The analysis, where possible, has been carried out anonymously without attempting to identify individuals with the exception of the interview-recording data [DATA_01] which, as individual interviews, were eponymous by definition. The interview data have been anonymized through the use of pseudonyms and have been processed anonymously. The qualitative and quantitative data presented in this thesis have also been anonymized at the analysis and reporting stages.

Generic and specific ethical issues were meticulously considered and addressed so as to guarantee the welfare of the research subjects, the quality of the research and the moral integrity of the researcher. Confidentiality was protected and the fidelity of transcription maintained by seeking clarifications during the interviews. Careful consideration was given at the analysis stage, in particular concerning the roles of the participants in the interpretation and validation of the interview findings, and the implications of publication of the results (Kvale and Brinkmann, 2009).

Timeline	Tools	Data	Type
ACTION_01	TOOL_01 DL Questionnaire DIGCOMP$_{v0}$	DATA_01 Coded Corpora	Qualitative (pseudo-anonymous)
ACTION_02	TOOL_01 DL Questionnaire DIGCOMP$_{v0}$	DATA_02 Activity 01 Self-assessment Questionnaire	Quantitative (anonymised)
ACTION_03	Diaries	DATA_03 Reflective Diary Analysis & Focus Groups	Qualitative (pseudo-anonymous)
ACTION_04	Focus Groups	DATA_03 Reflective Diary Analysis & Focus Groups	Qualitative (pseudo-anonymous)
ACTION_05	ACTION_05 Remapping the Results to DIGCOMP$_{v1}$	DATA_01 Coded Corpora	Qualitative (pseudo-anonymous)
ACTION_06	TOOL_02 DL Questionnaire DIGCOMP$_{v1}$ Student	DATA_04 Analysis	Quantitative (anonymised)
ACTION_07	Diaries	DATA_05 Student Experience (Online)	Qualitative to Quantitative (anonymised)
ACTION_08	TOOL_03 DL Questionnaire DIGCOMP$_{v1}$ Staff	DATA_06 Staff DL Validation	Quantitative (anonymised)
ACTION_09	TOOL_02 DL Questionnaire DIGCOMP$_{v1}$ Student	DATA_07 DL Toolkit II Classroom Results	Quantitative (anonymised)
ACTION_10	TOOL_04 Classroom Student Experience Questionnaire	DATA_08 Student Experience (Classroom)	Quantitative (anonymised)

Table 5 - Tools and Data

A summary of the tools and data are identified with a description of the data types and anonymisation methods.

The interviews were audio recorded (with consent), transcribed and analysed by using thematic analysis in NVivo (Guest, MacQueen and Namey, 2012). The analysis of the data uncovered underlying themes that were used to inform interventions at the curriculum design and delivery stages. The semi-structured interview instrument allowed for elaboration on the responses and provision of feedback which, otherwise, might not be possible. This approach imposed a loose structure that resulted in a natural response flow through which gaps were identified and completed during the interview process, while the interview remained conversational, inviting, and open to unscheduled contributions. During the interviews every possible effort was made to establish an environment in which the research subjects would feel comfortable to talk about private events. These were recorded, interpreted and disseminated. The interview protocol ensured that the participants were treated ethically and that the interviews were conducted in an environment that was safe, comfortable and relaxed (Cohen, Manion and Morrison, 2007). Ethical issues that were particularly relevant to conducting interviews resulted in exposing the participant's thoughts, experiences and feelings to the researcher and, after achieving consensus, to the wider public (Birch, Miller, Mauthner and Jessop, 2002). The research study, besides the scientific value it carries, enhanced the experience of the participants by researching their digital-literacy views and digital attitudes. The results informed practice, and through a number of learning/teaching improvement interventions, enhanced the digital literacy of students and staff.

3.4.2.1 Informed Consent

Participants had been asked to review an information sheet that was customised to their role (student or staff) and provide consent by signing the relevant participant consent form (see Appendix - Ethics Participant Consent Form) in writing for the interviews and electronically when completing the online questionnaires. The participant information documents (see Appendix - Ethics Participant Information Sheet Students & Appendix - Ethics Participant Information Sheet Staff) included generic information about the project, such as the purpose and value of the study, an invitation to participate, details of who was organising the research, details of how the results would be handled, acknowledgements of the sources of funding, the contact details of the primary investigators and a statement explaining the participant's right to refuse to participate, or withdraw from the study. It also included specific information on the actual process of withdrawing and reassuring the participants that involvement was optional and they would not be penalised or discriminated in any way. A brief explanation of the participation process was included alongside a statement of the identified risks and mitigation strategies that also included acknowledgement of the participant's legal rights.

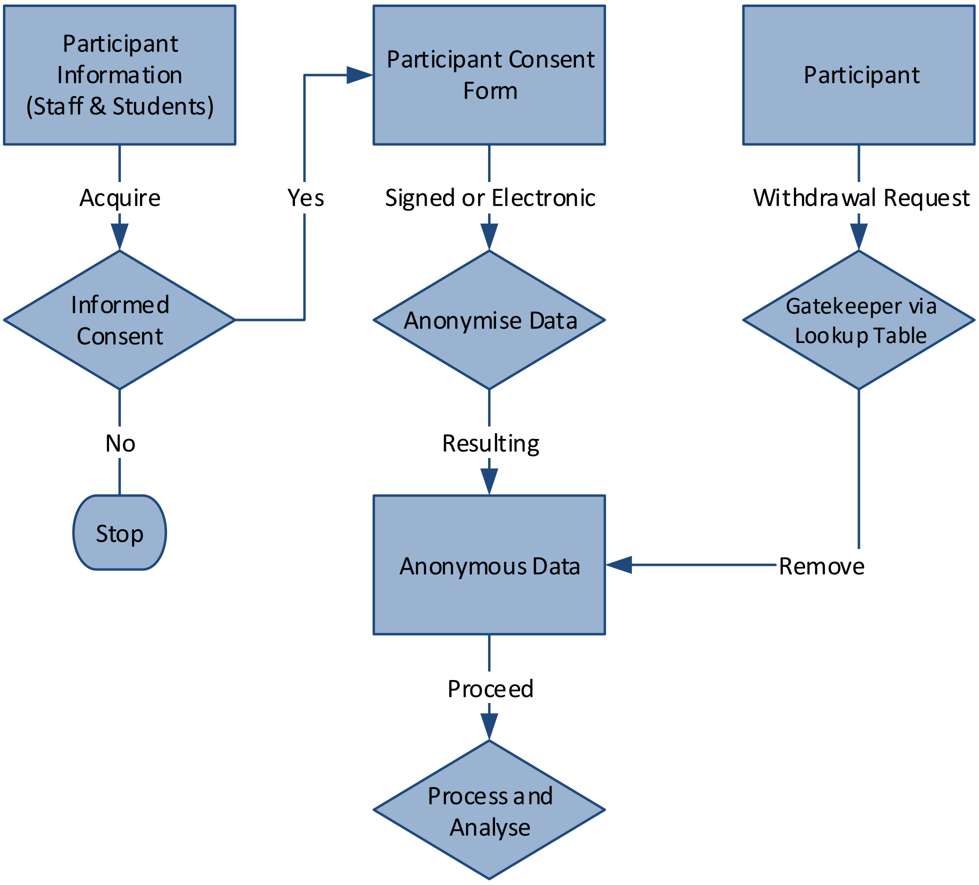


Figure 10 - Ethics Protocol

The ethics protocol workflow diagram. In summary, the participants have been fully informed about the research by issuing a tailored Participant Information Sheet. Informed consent has been acquired in writing or electronically where appropriate. Data have been anonymized by utilising a system of gatekeepers and look up tables. This process allowed for the removal of any data from the dataset in case participants decided to withdraw.

3.4.2.2 Data Protection and Privacy

A strong commitment and reaffirmation for safeguarding the participants' data and ensuring their privacy and confidentiality took place through adhering to the data protection policies, implementing the institutional processes and the handling of data according to the best of practices. Specifically, all paperwork was archived in a secure office space and any digital assets were kept safe in a password protected and encrypted storage. Privacy and confidentiality were implemented by adhering to the requirements of the Data Protection Act (Data Protection Act 1998) by following the institutional processes (Anglia Ruskin University, 2011). Sharing of data was kept to a need-to-know basis and data were accessible only by members of the research supervisory team that also acted as the data gatekeepers. The privacy of the participants and confidentiality of the data were also enforced in the analysis stage by following strict anonymisation protocols and ensuring that the data were kept safe and confidential at all times. The data management protocol identified two types of data, print and electronic. Files in print, such as interview schedules/questionnaires/notes and consent forms, were kept as evidence in a securely locked drawer at a monitored, secure office space, together with the laptop computer where the audio recordings of the interviews were stored and analysed, and the electronic questionnaire system, which was password protected and encrypted, all were protected by security during day-time and an alarm system outside office hours. Backups of all electronic files were stored securely on an encrypted backup storage device to ensure reliability and protection against unexpected hardware/software failure or other malicious threats.

The ethical principles and applicable institutional policies and processes were observed and monitored by the supervisory team throughout all the stages of the research. For example, when conducting the online activity intervention (intervention 2) that involved students' undertaking technology-enhanced learning activities on the Virtual Learning Environment (VLE), and at the stage of providing feedback on their experiences when a student decided to withdraw from the research and contacted the research supervisor who was acting as the data gatekeeper. The student's request was facilitated by responding immediately and removing all collected relevant data from the dataset.

3.4.2.3 Participant Selection and Gatekeepers

The research carried out under intervention 1 was open to all academics and academic-related staff associated with any of the healthcare courses within the faculty. All were adults of various ages. The age of the student participants was checked across all invited cohorts by enlisting the help of a senior administrator that diligently checked their ages in the institutional student record management system to ensure that they were all adults. Intervention 2 recruited from undergraduate first-year students on the Midwifery programme. These were selected as new to the institution and their views, thoughts and feelings were not shaped or affected by interactions with the institutional status quo. For intervention 3 students self-selected to participate from a group of student-nurses who were participating in a separate project that utilised mobile tablet devices as a mechanism to record the assessment of student-nurse competencies in clinical practice. In intervention 4 participants self-selected from a group of second-year Midwifery students. All relevant permissions to contact the tutors and students were granted by the Deputy Dean for Quality, the Acting Head of the Department, and the Director of Pre-registration Nursing. Students were contacted via the tutor groups, where an open invitation to participate was made after a short introduction to the project, through emails and announcements on the Virtual Learning Environment (VLE). The healthcare-education discipline was of particular interest, as the participants had or were required to develop a dual identity: this of a tutor/student within education and that of a professional healthcare practitioner in the workplace.

3.4.2.4 Risk Assessment

The assessment of risks (See Appendix - Ethics Risk Assessment and Appendix - Ethics Risk Assessment Check List) was conducted prior to the commencing of the research and in the case of intervention 1 identified additional risks arising from having to meet the interviewees physically. The interviewees were asked to fill-in either a printed or an electronic questionnaire that aimed to collect demographic information and provide a self-assessment of their digital literacy. The risks to the participants were thought to be minimal as extreme care had been taken to ensure their safety and welfare. Potential risks and mitigation strategies are summarised in Table 6.

Risks	Mitigation Strategy
Physical risks from conducting off-site interviews.	The researcher ensured that the interviews were conducted in appropriate accommodation on university grounds where security and first aid provision were always available. The researcher has also completed a basic first-aid training course.
Interviewees could become upset by the interview.	A friendly but professional manner was adopted when conducting the interviews without becoming over-familiar.
Exposure to data or information which may cause upset or distress.	Upon arrival the researcher's role and the conditions of confidentiality were explained to the interviewee(s) and the opportunity to ask questions was offered.
The known as the insider researcher dilemma: staff group members may feel coerced to participation. The dilemma does not apply to the student group at the same degree, though.	The fact that the researcher was a member of the staff, and in some cases an immediate colleague, was discussed. The participants were explained that they could freely contribute anything they wanted without any fear of their identity being uncovered.
Interviewees could become upset by the interview, or suffer psychological pressures and become a threat to the researcher.	All interviews have been conducted on university grounds.
Exposure to data or information that may upset or distress the participant.	The participants have been debriefed to ensure their welfare.
Poor participation rate from students.	The research recruited well. A backup plan to seek permission to extend the research to other cohorts and manage under-recruitment existed.
Poor participation rate from staff.	Recruitment of members of staff was satisfactory.

Table 6 - Ethics Risk Assessment

The Ethics Risk Assessment including the mitigation strategies for the identified risks.

Chapter 4. Phase 1 – Investigate and Innovate

This chapter reports on the first phase of the inquiry that investigated the first two research questions by assessing the applicability of the DigComp framework that focused to explore digital literacy in local practice, and experimenting with a model and processes for embedding digital literacy in the curriculum. The findings of this phase of the research are presented under the lens of the interactive research design that highlights the dynamic nature of development of this research. The research design of phase 1 attempted to answer the following research questions.

Q.1 Are digital literacy frameworks useful in supporting student learning in university healthcare settings?

Q.1.1 Are there any specific attributes of digital literacy in a healthcare education environment?

Q.2 In what ways can a framework approach assist us to understand how digital literacies manifest in student learning experiences?

Q.2.1 How can digital literacy be developed in a higher education healthcare environment?

This investigative and innovative stage of the research (see interventions 1 & 2 in: Figure 11) commenced with the examination of the appropriateness and usefulness of the DigComp digital-literacy framework to describe how students, academics and academic-related professionals perceive digital literacy within healthcare education. Having examined the appropriateness of the initial conceptualisations of the DigComp$_{v0}$ framework (Janssen and Stoyanov, 2012; Janssen et al., 2013) to articulate digital literacy in healthcare-education practice, the research proceeded to investigate the feasibility of utilising a design approach for the purpose of embedding digital literacy in the healthcare curriculum. In particular, this research phase investigated how digital literacy could qualitatively and quantitatively evaluate the student experience of undertaking online technology-enhanced learning activities.

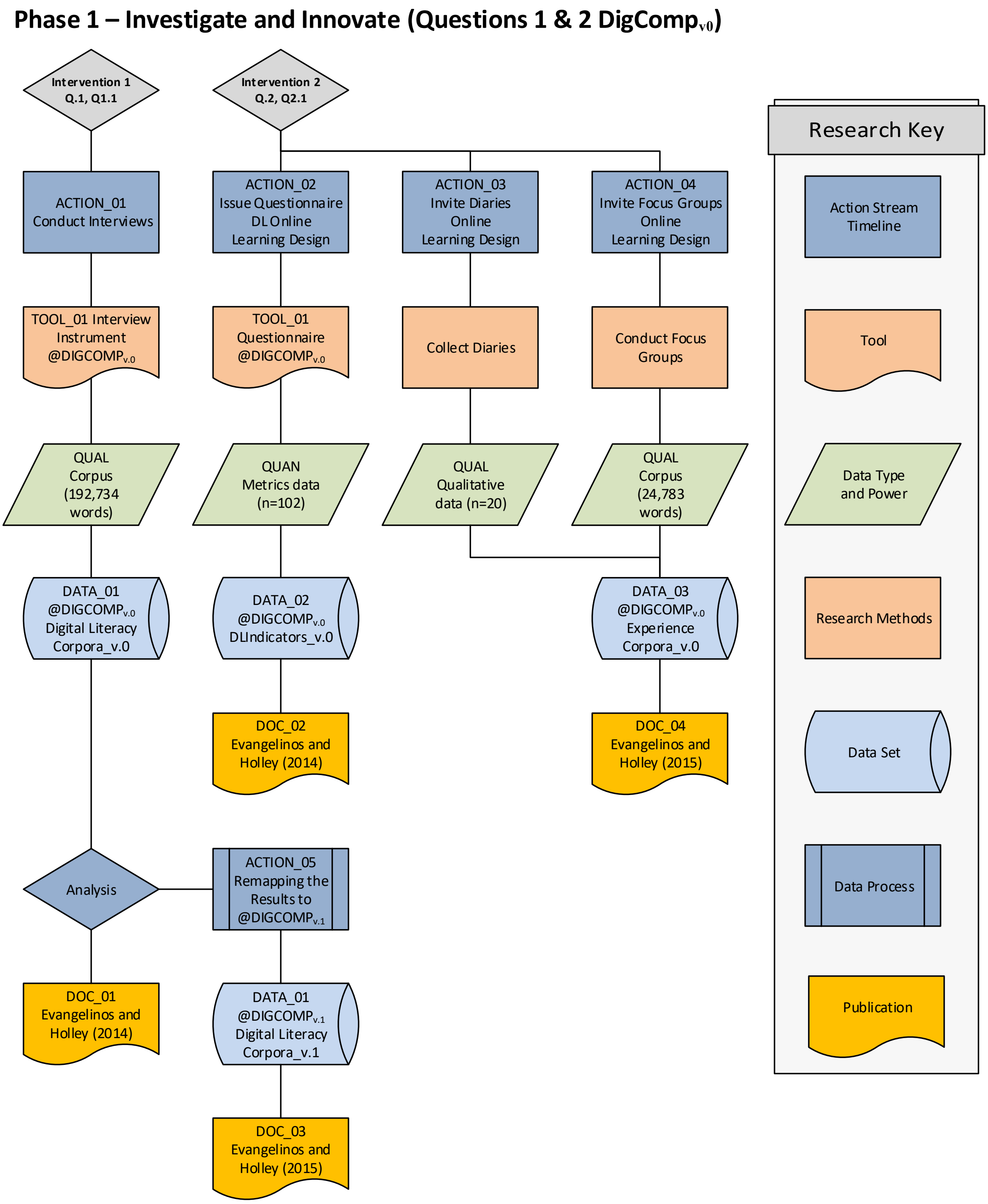


Figure 11 - Phase 1 Research Design

The research design for Phase 1 illustrated in terms of action, tools, data, methods and relevant publications. Phase 1 constituted of intervention 1 attempting to address research questions 1 and 1.1 and intervention 2 addressing questions 2 and 2.1.

The work commenced with conducting one-to-one interviews [ACTION_01] with students, academics and academic-related staff. A digital literacy self-assessment questionnaire [TOOL_01] was completed by the participants prior to the commencing of the interviews and was used as a guide during the interviews to highlight key-areas for discussion. The transcription of the recorded interviews produced a digital literacy corpus [DATA_01] of 192,734 words that described what digital literacy meant to the participants. It was following broadly the early structure of the EU DigComp$_{v0}$ framework. The corpus was analysed qualitatively, following a thematic analysis (Guest, MacQueen and Namey, 2012) by coding the individual responses onto broader themes that were categorised along the areas identified by the DigComp$_{v0}$ framework. Thus local practice was mapped onto the areas of the framework through the participants' experiences. The themes were later remapped [ACTION_05] onto the DigComp$_{v1}$ framework (Ferrari, 2013) taxonomy to align the results of the qualitative analysis with the revised structure. Students were offered a number of online digitally-enhanced study activities that were supplementary to their existing curriculum. The digital capability of students was benchmarked [ACTION_02] by a bespoke digital literacy self-assessment questionnaire [TOOL_01] which also derived from the DigComp$_{v0}$ framework. The embedding of digital literacies into the curriculum was assessed by qualitatively evaluating the student experience via a combination of short, reflective diaries [ACTION_03] and by conducting focus groups [ACTION_04].

During the analysis of the qualitative data a secondary question on finding out whether any relevant attributes of digital literacy were specific to healthcare education arose. This question emerged while considering the initial results in relation to the conceptual framework (see: Figure 5) and specifically when examining the research approach in relation to the areas of academics as teachers, and academics as disciplinary, expert professionals. It was postulated that if such disciplinary-specific digital qualities and capabilities were identified, they could be used as exemplars to embed digital literacy in the curriculum.

4.1 Intervention 1 (Actions 1 & 5): A Qualitative Exploration of the EU Digital Competence DigComp Framework

At the time of conducting the first intervention the DigComp framework was still under development and only the results of the baseline expert consultation (Janssen and Stoyanov, 2012) had been released in the public domain. Their study was carried out as an iterative Delphi-type survey that documented the interpretations of 95 experts. This work was part of the wider DigComp project, commissioned by the Information Society Unit at Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) on behalf of the European Union Directorate-General for Education and Culture. The early results, which focused on attitudes and participant knowledge of digital competence among experts in research, education, training and work, deriving from a wide pan-European expert consultation, were of particular interest. The framework was utilised and interpreted as a shared set of generic definitions. Therefore, they could be used flexibly to describe the wide variety of the users' digital experiences while engaging with technologies. The high-level themes, constituting the framework, can be seen in Figure 12.

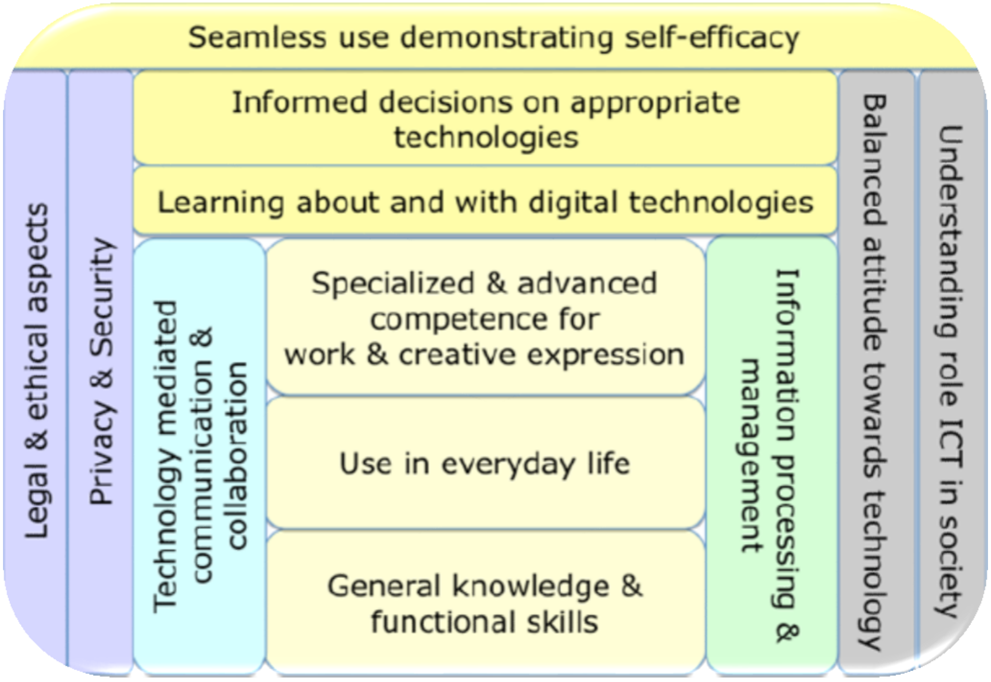


Figure 12 - Digital Competence Building Blocks

The Digital Competence Building Blocks as identified by the Online Consultation on Experts' Views on Digital Competence (Janssen and Stoyanov, 2012; p.4).

4.1.1 Methods

Whenever conducting qualitative research the interview can be considered as a professional conversation which objective is to discover the life-views of the interviewee on the research topic. Interviews are defined by Kvale (2009, p.2) as '… *it is an inter-view, where knowledge is constructed in the inter-action between the interviewer and the interviewee*.' Qualitative interviewing, a naturalistic research method operating within the interpretative paradigm (Lincoln and Guba, 1985), aims at uncovering meanings on the subject and should be conducted as an open and creative process where the interview subjects are free to express themselves and the researcher is free to record and analyse their authentic narratives. Interviewer and interviewee become co-constructors of knowledge by utilising conversation in an inter-subjective and social manner. There are many types of interviews ranging from the completely unstructured to fully structured, closed interviews, based on pre-determined sequences of questions. The deciding factor of the type of interview utilised in this research was based on the examination of its appropriateness. Highly structured interviews are more suitable when the researchers know in some detail what they are searching to find out, and articulate them in clear questions so that these to yield meaningful answers. Unstructured and semi-structured interviews are more suitable when a degree of uncertainty exists about the exact nature of what the researcher is trying to find out. Therefore, the formulation of clear and succinct questions appears to be difficult or even impossible at times. In these cases the formation of broad questions or themes is preferable, as these can be used to initiate and steer discussion (Lincoln and Guba, 1985).

In this research the interviews were conducted following a semi-structured approach. The themes of the interview questions were pre-determined, but the sequence and wording of the questions were adjusted in real-time by the interviewer as the conceptualisations of what digital literacy meant to individuals varied widely. Such an approach imposed a loose structure that encouraged natural responses to flow and gaps to be identified and completed during the interview process, while the interview remained conversational, inviting, and open to unscheduled contributions. Nevertheless, there were still risks imposed by using this semi-structured approach which might result in the loss of certain areas of interest. A risk was identified in that the looseness of structure and the non-standard phrasing might also result in the elucidation of significantly different responses which could be considered as a factor reducing comparability. For this reason intense care was taken to cover all topics even if the participants would not contribute any comments. The interview prompts were phrased as open questions without being too specific so as to allow for a variety of responses, taking into account that the participants might have a wide range of divergent experiences.

Reliability, in qualitative research can be better expressed as dependability. As Cohen, Manion and Morrison (2007, p.149) note *'... reliability includes fidelity to real life context-and-specificity, authenticity, comprehensiveness, detail, honesty, depth of response and meaningfulness to the respondents*'. Dependability in interviews is predominantly determined by the existence – or non-existence – of bias and happens because of the subjective qualities and presuppositions of the interviewer which are based on their views, experiences and expectations. The personalities of the researcher and the subject also play a role in introducing potential preconceptions or being judgemental. Attributes such as gender, race, religion, sexual orientation, age, class and status can all affect the interview process as this is an exchange of views between the interviewer and the interviewee. There are also other risks, such as the tendency to pursuing answers that support the researcher's views, misinterpretation of what is being said, or the understanding of the questions by the interviewee (Lincoln and Guba, 1985; Anfara, Brown and Mangione, 2002). The validity of the conducted interviews was affirmed by debriefing the participants and clarifying the areas where the interviewees' views could have been misrepresented. Another technique was used at the analysis stage where the data from the different interview segments were compared and contrasted to reinforce similarities and identify the differences. The transcription quality was assured through independent auditing of a sample of the interview material by an external team of professional transcribers to safeguard against errors. Ultimately, the likelihood of misrepresentation of the interviewees' opinions in the analysis was deemed to be low, as the purpose of the analysis was to map their individual experiences rather than seek evidence to validate a theory. As such the analysis, a collective analysis of individual views, was considered as highly dependable.

Within the interpretivist paradigm, especially when using naturalistic methods of data collection such as interviews, there are additional ethical and utilitarian legitimacy issues (Angen, 2000) that have to be taken into consideration. Ethical issues, particularly relevant to conducting interviews, resulted from the potential exposure of the participant's thoughts, experiences and feelings to the public (Birch et al., 2002). The researcher observed the principles of conducting research ethically by adhering to the institutional policies and processes and by acquiring informed consent to ensure that: a) the research was beneficial to the participants by sharing the tangible outcomes with the wider community, b) consensus was achieved concerning the interpretation and examination of alternative elucidations, c) there were safeguards against potential biases by cross checking that the evidence supported the interpretations, and d) reflective practices for the evaluation of the results and processes were utilised so as to achieve personal and professional transformation in practice.

These principles were satisfied by establishing a transparent research protocol (see: Figure 10) which ensured that the research was conducted ethically for the benefit of the participants as individuals, for the benefit of the institution, and the wider society in general. Informed consent was acquired in writing after having clarified the research protocol and the processes highlighting the rights of the participants, as well as the voluntary nature of participation. The processes for handling and analysing the data were also explained in detail and the participants had been informed that they could withdraw at any point prior to the data-analysis stage without suffering any adverse consequences. The contact details of a senior member of staff, part of the supervisory team, were provided to the interviewees to ensure that the participants had access to an informed named individual to report and discuss any potential issues.

A complexity, identified early in the project, was the question on how participants perceived digital literacy and contextualised it. Based on the initial findings and conclusions of the relevant case-study research literature (Joint Information Systems Committee, 2013) it was postulated that the participants had their own individual thoughts, ideas, views, experiences and feelings on the topic of digital literacy, and that they would not recognise the terminology used within the digital-literacy framework. This was amplified by the chosen research approach that was interpretative in nature and the loose structure of the semi-structured interview research format. In order to manage the impact of these challenges a self-assessment questionnaire [TOOL_01] was constructed based on the early results of the online expert's interview consultation (Janssen et al., 2013).

The questionnaire was tested with one participant to assess its suitability to be used as an instrument to guide the interview process before commencing the bulk of the interviews. An examination of the results of the pilot interview confirmed that the use of the self-assessment, digital-literacy instrument to flexibly guide the discussion was a viable approach that produced a wealth of qualitative data. It was observed that the discussion remained focused on digital literacy and that all the areas had been covered while, at the same time, it facilitated the focusing of the discussion on self-reported strengths and/or weaknesses. Thus a better understanding of the individual's experiences was gained by focusing the investigation of the digital literacy areas of the framework through examining, in more detail, the examples offered by each individual. From a practical perspective it also uncovered the existence of performance-related stress in both, the interviewer and the interviewee. However, on closer examination, the apparent stress dissipated after the first few minutes of discussion. This phenomenon was attributed to the fact that the interviewees were not sure of what was expected of them and the interviewer was initially focused at discovering whether useful information could emerge from the loose interview structure. During the pilot interview themes and areas of interest were emerging naturally, albeit not in the expected order, or within the boundaries of the selected themes. The researcher was extremely careful to allow for the participant's views to develop, while clarifying any vague points and offering modest amounts of feedback to facilitate discussion. It must be noted that the interviewer was actively trying not to offer his views or examples, being cognisant of the risk of influencing the thoughts of the interviewee. The pilot interview lasted for ninety minutes and, by its end, fatigue was apparent on both parties. In order to ensure the welfare and optimal performance of both parties it was decided that a short break would be necessary.

The interviews were carried out according to the hermeneutic methodology (Lincoln, Lynham and Guba, 2011) using a dialectic approach with 11 participants. In particular, 5 academics, 3 students and 3 academic-related professionals involved in healthcare education self-selected for interview. The inclusion of interviewees representing key stakeholders in healthcare education internal to the institution was deliberate as the investigation of the appropriateness of the framework had to be representative of a variety of the main healthcare education stakeholders' experiences and views. The participants provided informed consent in writing according to the requirements of the institutional ethical procedures. Interviews were arranged at the convenience of the participants on university grounds, as per the established research protocol, to ensure the safety and welfare of the participants and the interviewer. The audio recordings of the interviews lasted from 90 to 120 minutes and formed a transcribed corpus of 192,734 words. The average duration of the interviews was similar to the duration of the pilot interview when a fifteen minute break was added.

In order to gain an informed insight on the views and experiences of the participants and evaluate their perceptions of their digital competences, they were asked to describe, comment and elaborate on their choices in the self-assessment questionnaire. Documenting and analysing how digital literacy was interpreted by the participants according to the $\text{DigComp}_{\text{v0}}$ framework, definitions and classifications enabled the assessment of its applicability to describe digital literacy in healthcare education. Baker and Johnson (1998), Walford (2001) and Kvale and Brinkmann (2009) assert that this naturalistic method of enquiry enables a more flexible approach in capturing the participants' experiences, perceptions and detail of understanding on the subject-matter. The transcribed interview corpus was investigated through the use of the QSR NVivo 10 software (QSR International Pty Ltd, 2017) by coding the data into emerging themes, following the recommendations of Miles and Huberman (1994) and Guest MacQueen and Namey (2012). Theme patterns were formed by summarising and counting the digital-literacy references reported by the interviewees. In addition the number of individuals commenting on a particular theme was also counted to assess its relative significance. The emerging themes were subsequently categorised according to the classifications of the $\text{DigComp}_{\text{v0}}$ framework areas to investigate their suitability. During the mapping process it was observed that in many cases the responses formulated a number of second and third level sub-themes. The research question related to an evaluation of the appropriateness of the DigComp digital-literacy framework in supporting student learning in university healthcare settings based on the perceptions of the institutional stakeholders. After reflection on the time-cost and benefit analysis with respect to the criteria set by the research question, it was decided that coding at multiple sub-theme levels would not add value to the analysis and for this reason it was omitted.

4.1.2 Interview Results and Analysis

Overall twenty-two themes emerged and were categorised according to the areas identified in the $\text{DigComp}_{\text{v0}}$ framework in Table 7. Seventeen of them were mentioned by most of the participants; five top-level themes (based on the framework taxonomy) and nine sub-themes (arising from the coding of interview data) presented an above average number of references. These themes have been classified as dominant and the rest as secondary. The numbers denoted inside the parentheses appearing next to each framework area and theme, indicate the number of participants that made a comment relevant to the area/theme and aggregate the number of individual references. An analysis of the dominant and secondary themes, that arose during the interviews, follows.

Dominant Competence Areas	Secondary Competence Areas
Use in everyday life (11/205) - Technology use (11/116) - Technology-use barriers (9/47) - Digital devices (10/28) - Online banking (8/14) **Specialized and advanced skills (11/119)** - Technology use in education (9/86) - Content authoring and remixing (11/22) - Specialist digital skills (9/11) **Learning about/with technologies (11/97)** - Learning skills and support (11/85) - Learning about new technologies (6/12) **Technology mediated communication and collaboration (11/89)** - Communication/collaboration (10/43) - Social networks and media (11/37) - Communities of practice (5/9) **Balanced attitude (10/76)** - Balanced use of technology (10/76)	**Privacy and security (11/55)** - Security and privacy (11/55) **Information management (11/54)** - Managing information (11/54) **General knowledge and functional skills (7/38)** - Manuals and instructions (7/16) - General knowledge (5/9) - Hardware and software (7/9) - Operating systems (4/4) **Legal and ethical aspects (9/33)** - Legal and ethical aspects (9/33) **Understanding and awareness of the role of ICT in society (8/20)** - Social issues (4/11) - Technology and the environment (4/9) **Informed decisions on appropriate digital technologies (0/0)** - N/A **Seamless use demonstrating self-efficacy (0/0)** - N/A

Table 7 - Interview Themes Mapped onto the DigComp$_{v0}$ Framework Areas

Themes that resulted from the analysis of the interview data when mapped against the areas of the DigComp$_{v0}$ framework. The first number next to each theme indicates the number of participants that mentioned the theme and the second number is the number of references.

Use in everyday life (11/205)

Unsurprisingly, *'Technology use'* was the most commented high-level theme as this was an expansive theme that captured a wide variety of user experiences that could not be neatly categorised under one of the other themes. Admittedly, this theme was very broad but necessary to classify a wide variety of the participants' experiences that did not fit nicely in one of the other themes. The relatively high number of references was partly due to the non-prescriptive nature of the used questionnaire instrument. The participants reported common attitudes and approaches in the use of technology by identifying various examples of e-commerce and e-Government services, including the use of online systems for engaging with the taxation services and for renewing driving licences and passports. They also identified various examples of technology use for leisure activities such as the use of digital technologies to listen to music, watch videos and TV programmes, read books, take videos and photographs, access online information and news and edit videos. Examples of technology use at work included the use of mapping services, word processing, video editing and job hunting. A participant, commenting on how technology has enhanced their life in general, said, '*I think it's quite enhanced our lives hasn't it? … like with my brothers have been abroad, I wouldn't be able to be in contact with them really, only by phone call. So I think you know, actually it's enhanced quite a lot and you can … well, you can do everything on line really, can't you?*' Examples of the use of technology, specifically in healthcare, included the online or over the phone booking of medical appointments, getting the results from clinics as text messages, digital vital-sign monitoring and tele-care. An example of how technology is increasingly being used in healthcare, articulated by an academic interviewee, identified that, '*For example in the past nurses typically going around doing observations on patients would do somebody's blood pressure or feel their pulse and then chart it on a piece of paper on a chart on the end of the bed. Now they go around and do that and enter … all that data onto a digital system and its all downloaded to the main desk on the ward and its projected for, whoever needs to see it ... to interpret it and those paper charts are going to become a thing of the past like x-rays now people who have an x-ray and the information is sent to a screen …*'

However, a number of barriers, summarised under the theme *'Technology-use barriers',* were articulated by the interviewees. Academics commenting on the observed behaviours of their students described that the use of technology for carrying out relatively simple tasks such as referencing could be challenging for some students. Attempting to elicit further insights on this observed phenomenon it was postulated that this might be due to lax student-engagement with institutional technologies or, as one academic quoted, by '*lack of student motive*', and not because of lack of engagement with technology in general. It is interesting to note that attitudes towards technologies play a significant role in developing digital literacy as a technological capability but this is not enough. Students should take charge of their own learning and become independent learners. In relation to the concept of learner engagement academics also described that many students see learning as '*parts of knowledge related to assessment*' and not as an ongoing life-long developmental process for self-improvement. An additional barrier was identified in that some students, due to lack of the necessary digital capabilities, are completely disengaged from technology. As one participant put it, '*Some students I could email from now until eternity and they may never read any of the emails that I send*'. Other learners, although digitally capable and engaged, use only specific platforms and technology (for example smart phones and social networks). Learners also seem to exhibit diverse personal and professional digital identities. When an academic attempted to enrich their teaching with technology, it was observed that students perceive their digital devices and especially their smart phones as technologies for private use and not for learning or work. She recounted '*... they keep them very separate and they don't appreciate that there are some transferable skills there ... if you go on YouTube and see a video then you can do the same thing in a way which to learn.*' This interpretation was supported by the fact that when students were required to use an alternative type of digital technology, such as a tablet or a laptop, their mentality often changed and they became more receptive in utilising it for study or other work. This indicated that learners associated particular technologies with specific uses and they did not always recognise that they possessed transversal digital competencies that could be used across different domains. Additional factors that act as barriers have also been identified in attitudes with one participant reporting that '*I do get very stressed very quickly with computers because I'm fine once they're doing what they're supposed to be doing but as soon as it goes wrong, I don't know my stress level goes right up here.*' Another interviewee admitted that they do not really engage with technology out of choice and commented that '*... I cannot understand why people want to have all those phone calls, all those text messages to tell people what they're doing and done every hour of the day. I have no space for that in my life.*'

The interviewees mentioned that they used a variety of '*Digital devices'* including laptops, tablets, smart phones, e-book readers, music players, game consoles, GPS guidance systems and hands-free phone utilities for in-car use. A number of different brand names were mentioned including Apple (iPhone, iPad, iPod, Mac) and Android, as well as the common term Personal Computer (PC) implying a Microsoft Windows platform. Some of the interviewees had multiple devices and they exhibited a preference on using a specific device when the completion of a familiar task was required. The choice of device was often related to size, or portability afforded by modern devices, and to its functionality and ease-of-use. For example, they were comparing a laptop computer to a tablet, and a digital video-camera to a smart phone. An academic, referring to digital devices, observed that, '*... a lot of the students have them as well ... so it is helpful in class I find as well with regards to tablets and ... phones ...*' Academics also seemed to differentiate between privately owned and work-provided devices. They used them for private and work-related tasks respectively. However, a student reported the use of devices according to her own needs stating that, '*It is a smart phone but I don't care enough to really use it as one most of the time.*' She was aware that her smart phone could be used to access the internet and use a variety of apps, but she only used it to make phone calls, texting and taking photographs. Another student mentioned that the cost of technology was an issue when growing up recounting that, '*We didn't have a PC in the house as I was growing up, until I was about 16 but then friends introduced me to different types of ... we did have you know like games consoles ...*' Another student also reported that cost was an issue for owning digital devices stating that, '*I have a Smartphone. I'm not rich enough to have a tablet at the moment! But hopefully in the future I will. But I've got a laptop, of course; I've got a mobile phone which I'm using quite a lot for my work purposes ...*' Finally, a student expressed some serious concerns about the increasing trend for having to use online services, identifying that '*I think that's a nightmare in itself because you have to do everything on line and you have to communicate with them on line, there's no telephone at all and that really does do my head in, really does but yeah but I suppose it's security thing as well, isn't it?*'

'Online banking' was another theme that emerged during the interviews with the feedback clustering around three categories: a) those who avoid it, b) those who find it difficult and c) those who use it and find it beneficial. Almost half of the respondents were clearly against online banking and online payments because of security concerns. One of the participants when asked if they used online banking or digital payments replied, '*I don't. Online banking*

is one thing I'm very sceptical ... and the idea that you can access my information with a password that simply, it makes me quite uneasy, particularly when you're talking about large amounts of savings that you've spent a long time building up. I'm just generally sceptical about online security for most things.' A few of the participants found the online banking processes difficult to use, especially because of the need for remembering the passwords and the multiple security questions. For example, one participant stated, '*You know, it's inconvenience to try and remember all these ridiculous passwords and security codes.*' Another respondent, actually not in favour of online banking, admitted that they used it out of necessity and testified that '*Sometimes ... yes only because I have no choice. I'd rather not do it. My bank account is [abroad], I can't check my balance here with my cards, so I have to go online you know? If I had a choice I wouldn't.*' On the other hand, a smaller number of participants mentioned that they used online banking as they found it easy to access, monitor their financial accounts, and carry out online payments of sorts. One participant was very enthusiastic about it and reported that '*Yes, no I'm totally Internet banking ... I can transfer money ... I can pay my daughter through the Internet banking. I can send my son money ... So yes, everything that I do apart from going down to see ... to pay something in if I've been given it, it's nearly all by credit card and Internet banking.*'

Specialized and advanced skills (11/119)

A noteworthy theme arising from the shared characteristics of the participants that were all students or academic professionals was *'Technology use in education'*. The participants were intuitively drawing examples from their lived experiences and engagement with the academic institution. The examples of technology-use within this theme can be broadly described in terms of technologies used for learning within and outside the classroom. Examples of technologies used in the classroom included digital systems for taking notes, digitised learning resources, electronic hand-outs, visual aids and mind maps. An academic reported that, '*... if you are doing group work and there is a certain thing you could ... you know the white boards ... are very interactive but if you want ... somebody just to use ... to search ... or to show 3 or 4 students something then the iPad is very good for that.*' The participants reported that the use of learning technologies, such as recording of lectures, visualisation software, and the use of audio-visual learning resources enhanced the classroom delivery, especially when it was combined with active teaching methods they made it appreciably more engaging. An academic explaining how they proactively attempted to engage students by utilising multimedia in the teaching recounted, '*I'm trying to integrate more individual multimedia in my teaching. I think it makes it more interesting, interactive, engaging with the students, and fun for me, to be honest, fun for the students. Because we also like to enjoy.*' Additional technologies commented upon by the interviewees were social media, videoconferencing and digital assessment systems. These were found useful in facilitating learning at a distance. Some found the creative use of media platforms for blogging, and especially video-blogging, easy to use and conducive to their learning. An academic commented on how the Virtual Learning Environment could be used more effectively to facilitate some of the teaching practices and elaborated that *'... so I think they benefit from more interaction with the VLE because sometimes we bring them in to do group work and actually they could actually do that at home and we could do it via VLE rather than having them all sitting in a class room saying you know or you know, you need to critique this article. Well, they could do that at home and we could have a discussion about it on the VLE and I don't think we do that enough.*'

A theme formed around '*Content authoring and remixing*' summarising the comments that were relevant to digital content-creation, manipulation and mash up. Academics drew from examples of creating learning material reported that, although sometimes reusing material from colleagues or reusing resources from the Internet is beneficial, on occasion they '*prefer to start from scratch ... instead of using somebody else's work*'. A few examples on how they used technology to edit images, videos, digital documents and digital presentations were offered. One academic explained that, '*I did a presentation the other day on equality and I wanted to take out some images and some video clips and put them in to the presentation ...*' A digitally skilled academic-related professional colleague, while explaining how they got involved in creating some videos in support of a new course, described that, '*... when the [removed to protect anonymity] course was going to be revalidated to be delivered out in Malaysia, we did some [removed to protect anonymity] videos that [removed to protect anonymity] and I filmed ... so I did my little mini refresher on Final Cut Pro, and then we had about four hours in the edit suite to finish it ...*' Students reported that they were able to create and mash-up digital content exhibiting varying degrees of ability. One student remembered, '*Yeah and we've done like little video things as well, yeah.*' Other students identified that sometimes the type of technology used could be a barrier in carrying out a specified task, with one student reporting that, '*I don't feel that confident about chopping and changing things really ... if it's on a computer and using* *software like that, then I'd probably ... I don't really know what I'm doing. If it's on the phone and I'm changing an image or something, then yeah, I'd know what I was doing ...'*

Another theme reporting on the details of *'Specialist digital skills'* was developed by analysing the data from the interviews. Some academics recounted the use of interactive white boards for teaching and creating narrated videos as learning resources. The academic-related professionals reported specialist skills in video editing, programming and using design applications. For example, one participant notes, '*I suppose like creatively, I suppose like I say about a year ago when I sort of really started with it ... with PYTHON, like I've been learning this language ...*' A small number of students identified a number of specialist digital-skills in using image-editing software, creating and editing videos, coding and setting-up computer hardware. A student mentioned that, '*I used to ... I used to be able to read HTML coding and so I built stuff around that but I haven't done that in about five years now because I just got bored of ...*', while another replied that they feel confident to meddle with their computer hardware and stated that, '*I'm happy replacing memory or something a bit more substantial, that's fine ...*'

Learning about/with technologies (11/97)

Another important theme arising from the comments of the participants was that of acquiring technological knowledge. This is summarised under the '*Learning skills and support'* theme. A number of ways for acquiring digital skills were reported. These could generally be characterised as on-the-job, peer-learning, self-directed and classroom-based. A specific example highlighted by a student was that of peer learning which demonstrated how students value learning from each other. She recounted, '… *we had the little bears you know for Children in Need, I set the bookstall up here and I did a little thing just copy and paste with all the bears. She said, "Did you know that you can have the bears round the other way and dancing?" I was like, "No, I said, I didn't know that." So she said, "Yeah you just click on that and you've got like dancing bears." So you learn all the time which is a great thing.*' Prominently, a number of participants reported that they were experiential learners, that they learn best by reviewing examples and when applying their newfound knowledge within specific contexts, rather than through an abstract narrative process. There was consensus that frequent engagement with technology reinforced learning and that they appreciated it when the benefits were explicitly articulated in advance. There was also wide consensus that support and availability of help were important to them. Some stated that without these they feel helpless or even panic. One academic highlighted, '*… better on a one-to-one basis and with continuing support [laughs] it tends to be the best way for me.*' Commenting on the same theme the majority of the participants reported that they often seek help from friends or family and only a minority of confident ones seek to find answers online. All participants commented that they learn best when they own the equipment, as this enables them to learn by using the technology informally. Some suggested that online guides and e-learning were valuable resources but these should not replace the more traditional forms of learning and support. One participant explained how owning a device acted for her as an enabler to engage with technology as she did not feel under pressure of breaking the device. She explained that, '*Once it's my own … do you know what it would be fairly different if it was somebody else's device, I wouldn't do it. I'd probably ignore just in case I'd break it or something. If it was my own, yeah no problem if you break it …*'

Participants remarked on a number of ways on *'Learning about new technologies'* offline and online. A few of the participants mentioned that they usually become informed on new technologies by word of mouth and advertisements and, in case something interests them, they conduct a more detailed market search. Additional information is often found on the Internet through reading online reviews, visiting online stores and monitoring social media websites, such as Twitter and Facebook, as well as offline, by seeking advice from family and friends and by visiting stores in person to browse for products of their interest. One participant reporting on how they find out about new technologies on social media describes, '*One thing I really like about Facebook and Twitter is you learn about things that you're interested in purely from the people that you share those interests with. So you'll end up following a whole bunch of things that you picked up from other people, and a whole other bunch of things that you picked up from them, and it sort of spreads out. So actually, your awareness of what's going on is greatly informed by a whole tree's worth of other sources.*' Another participant warns about the need for being cautious when searching for digital devices, and suggests a strategy of triangulating the reviews. She describes, '*I got a [brand] phone a little while ago and it was awful, I hated it … I just couldn't use it at all, it was awful and I ended up selling it on eBay and buying the [brand] and I've had [brand] ever since but ever since then I've always gone on checked all the reviews to make sure there weren't any glitches or anything with it because the [brand] that I had had so many glitches with it was awful. So since then I do, I always go online, I check the paper or I put it on Facebook and ask people just to make sure before I commit myself.*'

Technology mediated communication and collaboration (11/89)

The vast majority of interviewees commented that they used technology to facilitate their *'Communication and collaboration'* needs. Most of the participants reported that they use social networking and online audio-video conferencing tools to communicate with friends and family. Members of staff reported, to a smaller extent, that they collaborate with their peers at work and students who work remotely are enabled to keep in touch with their study groups. One student recounted, '*... I had to do like I had PowerPoint ... sort of thing but we all live miles apart, so we used email, Facebook ... obviously texting and that sort of thing just to sort of make sure ... so we all had certain sections to do and then I don't know, we just stayed in contact.*' Some participants indicated a strong preference for using specific platforms such as Facebook rather than using social networking tools in general, as they found some of them intrusive or cumbersome to use. A number of participants explained that the most significant enabler for using online videoconferencing tools was the cost that was perceived as being considerably lower than that for other technologies, for example telephony. They often use these audio-video conferencing tools to communicate with family and/or friends abroad, stating that otherwise this would not have been possible because of the prohibitive cost of using alternative technologies. A student described, '*I use Skype quite a lot for family back home and it's less expensive than a phone call.*' A small minority of the respondents mentioned instant messaging technologies as a precursor to the more advanced modern systems, and as an enabler for digital communication. One student recounted '*... before there was Skype there was MSN and stuff like that and I've always ... before that there was AIM ... oh God, AIM makes me feel old but yeah.*' A sizeable minority also mentioned Short Message Service (SMS) and email on smart phones as a way of communicating with work, friends and family. One member of staff reported, '*... but that's my emails always come through to my phone, I only ever really do them, unless it's a long email I need to reply to then I'll use the lap top, if it's just a quick checking of my email I'll use my phone ...*'

Advantages of using online digital technologies to communicate and collaborate at work have been identified by another member of staff explaining how their use is beneficial in terms of saving time and reducing business costs. '*Excellent, video conferencing, I mean I think that's absolutely brilliant, it's cost effective ... brilliant. Rather than people driving all over the place and petrol costs like that, I said couldn't we do video conferencing?*'

However, some of the participants were sceptical about the increasing use of these technologies in the workplace with one staff member reporting that, '*I've set Skype up for people at work, but I don't really use it myself. I don't really use video chat much, it kind of creeps me out a bit.*' Along the same lines a student reported that they felt online conferencing was not always the best solution and clarified that, '*I think you should leave academics to a more formal structure. Like if you want to see your tutor, make an appointment with them ... make an appointment face-to-face because communication over media can be taken up in loads of different contexts.*'

Participants discussing their digital-technology use, mediating communication and collaboration, made comments pertinent to *'Social networks and media'*. Specifically, the discussions clustered around two themes: a) the use of social networks in education, and b) their advantages and disadvantages. A small number of academics mentioned that they experimented through encouraging the students to use social networks for the purpose of engaging in informal and self-directed learning by forming study groups. They also mentioned that the establishment and facilitation of semi-official study groups on social networks was originally requested by the student body. However, when this was set-up, they found out that practically it was not required, as students had already formed their own informal online study networks. One academic offered some interesting insights of managing the online behaviour of students when they access external to the institution systems, and offered a solution based on self-moderation and establishment of a code of conduct, or online behaviour etiquette remarking that, '*I mean we try and do that as part of building it into the ground rules ... I don't sort of facilitate or moderate, you know, what goes on, on those ... I think you rely on people to moderate it ... themselves and obviously make it clear to them to say ... it needs to be, could be moderated so ... we are aware ... that there are limits to what it could be put on ... so we wouldn't expect for example people to post personal details of say patients under any circumstances we wouldn't expect them to make personal comments say ... about other students or members of staff ...*'

Comments relating to the perceived advantages of using online social networks included interacting and communicating with communities of interest, seeking employment and facilitating the organisation with events and collective action. A couple of the academic participants mentioned that the healthcare sector has increasingly been utilising social network tools to communicate with professionals in the workplace and with the public, and they felt that this is a trend to be embraced for the benefit of their students. Another reason, due to which participants found social networking sites useful, was the offered possibility of utilising them as a new way for communicating on a one-to-many basis. One of the academic staff mentioned that, '… *we'll be out like shopping and then all of a sudden there's a picture of our shopping on Facebook and I think, I say to them what have you done that for? Well, just thought I'd tell my friends what we're doing and I just think … it's not me but people do it … I could do it if I wanted to but I don't want to.*' A similar argument was put forward by one of the students who stated, '*Sometimes or just generally because people … I know this sounds awful but people like let me know how such and such goes and you can't be bothered to text them so I just put it on Facebook.*' Disadvantages have also been reported insofar, as a perceived tendency for negativity against social media, privacy concerns, the celebrity culture, blurring of identities, and concerns about personal and professional boundaries and interactions. A student reported that they would not welcome the informal networking with their academic tutors and commented that, '*As much as I love technology it is actually kind of scary in a sense … I think you should leave academics to a more formal structure.*' A member of staff likewise found that the use of social networking was not really working for them, and recounted that '*I don't know, I've ended up with sort of just almost being a voyeur of old school friends and stuff and because I wasn't really engaged with it and putting anything on their myself, I just thought this isn't for me … maybe some sort of privacy things as well, a little bit, I was just sort of I think I don't know, I'm not sure beyond that.*' With respect to the healthcare sector an academic warned that, '… *in terms of Nursing and professional body for Nursing is very sort of sensitive about issues around uses of social media.*'

'Communities of practice' were also discussed as a specific theme by some of the participants. The comments included seeking support from online communities in cultivating study skills, or when seeking advice in specialised topics and connecting with people who have similar interests. A member of staff explained how she met an expert on her topic by participating in these online communities while conducting research. '*Yeah, there's an English professor at Yale who had a student doing a PhD equivalent on a similar topic … so I was having a conversation with him about it by email for quite a while. That was quite useful.*' Another aspect that was emphasised during the discussion was that learning is often a social function and, as such, it requires engagement with the communities of practice. As one academic put it, '*Because to me the whole point of learning is about*

learning from each other, from other people, the communication, the group work, that's the whole essence for me of education.' Along the same lines another academic explained how communities of practice are very important in fostering inclusiveness, and observed that, '*You don't get the feeling of being part of a group. All of that arranging workshops and arranging extra outside stuff so you can discuss things should be part of anyone's experience. And if you have to do it online that's great.*'

Balanced attitude (10/76)

Under the *'Balanced, safe and efficient use of technology'* theme it was examined how participants feel with and without technology, and their perceptions on how technology can be used safely in a healthy way. The vast majority of the interviewees commented on the importance of technology in their lives and reported negative feelings when technology was unavailable to them. However, in one case a participant described how they were cognisant of not becoming depended on technology by avoiding its use when not essential. Comments such as, '*I could survive but it will be hard*', '*iPad and phone are never off*' and '*... there are very close to my heart but I could survive without them*', signified dependency. In cases this sort of dependency is so entrenched in the everyday lives of the participants that they may not even be aware that they are using technology although, in fact, they may be using multiple technologies. For example, they may be using a phone/tablet while watching TV. The health and safety aspects of technology-use, important to the participants, encompassed keyboard positioning, having a correct posture, screen size, use of light, having a foot rest, lighting conditions and protection of their hearing. Interestingly, the participants also reported experiencing technology-induced stress due to digitally-mediated, unrelenting information overflow. One member of staff observed, '*It is very interesting, and I have to say, the boundary became very blurred between what is personal and social, because sometimes you use ... you've got an email that's urgent at half past six in the evening - technically you shouldn't be responding to that because it's outside hours. But you feel you have to because otherwise a major problem will occur.*'

Privacy and security (11/55)

All participants made comments relating to the *'Security and privacy'* theme. These comments could be broadly categorised in three main areas: a) technical details and precautions, b) identity and information theft, and c) online tracking. Technical aspects were discussed in the context of virus protection, use of firewalls, managing and protecting accounts and passwords, and examining the online identity certificates. It was noteworthy that, although the majority of the participants were concerned and aware of the need for securing their systems and protecting their privacy, only a few could say whether they had taken any countermeasures and why, or describe them. Most of them seemed to be reliant on the automated, built-in systems of their devices for protection. Information and identity theft was another topic that was discussed extensively.

Interviewees were generally aware of what information and identity theft meant, although only a minority of them were able to articulate methods to safeguard against it. A couple of students mentioned that they knew a friend who had fallen victim of identity and credential theft. This fact made them become more aware and cautious. A member of staff described how one of their students had fallen victim of identity theft and the impact this situation had on the victim's studies. They recounted, '*... one of our students had her identity stolen. She was enrolled at four or five different universities, was enrolled with the Student Loans Company with four or five different identities. I actually had an email from someone pretending to be her from a personal email account asking to withdraw her form the course. I rejected it because it wasn't from her student email account, and when I sent the rejection to her student email account as well she let me know that that wasn't actually her. She had to intermit for a whole year and it got through the criminal court and everything, so that was quite intensive.*' Only a minority of the participants was aware of email and telephone phishing attempts and that sometimes fraudsters pretend they belong to an established entity and use various techniques to decipher personal information or credentials that can be used for fraudulent activity.

A few of the interviewees also mentioned that they had experienced the effects of online monitoring and tracking in the form of targeted advertising, and most of them stated that they did not like it. One student participant remarked that, '*... when you clear your cookies and then it's like interesting because suddenly the adverts are all completely different ... well like when I was looking for ... [a] ring suddenly seeing all the adverts did go to suddenly like rings ...*' It was interesting to find out that, although all participants who commented on online tracking were annoyed by the serving of targeted online advertisements, none of them was aware that they had already signed up for these advertisements by agreeing to the terms of use of the online systems and websites.

A number of the participants offered some healthcare-related examples. Such an example, offered by one of academics, explained the importance of ensuring the integrity of practice assessment and safeguarding against fraud when assessment documentation was completed in clinical practice and the importance of ensuring that credentials remain private and not shared in the clinical areas was highlighted. It was explained that, '... *always wanting to be sure that students are aware, particularly in clinical practice that ... say somebody is logged in ... has to log in to do a specific clinical investigation ... a test on a patient and ... if someone who is not authorised to do that test either uses that person's login or carries on using a piece of machinery that has been logged in by the person and there is a problem or an accident ... just that whole ... whole ethical issue of ... identifying these things really.*' A student described a situation identifying why healthcare professionals need to be extremely vigilant in safeguarding the privacy of their patients because even a minor detail could contribute to the identification of a patient and lead to loss of privacy.

Mitigation strategies articulated by the participants involved the establishing of correct privacy settings, avoiding to divulge sensitive personal information, not revealing their location, utilising intermediary systems when paying online, being aware and alert of strangers when inputting pin numbers, safely destroying paperwork that includes personal details, safeguarding passwords and devices, using online aliases, checking the online security certificates, being aware of how to protect themselves, and behaving responsibly in general. A hyper-vigilant member of staff, while describing how they protect themselves from identity theft by being proactive, explained that, *'... and not only that, I think I find the technology good for ... I send very few letters and if I have to send somebody something, I can usually scan it in and send it via email, which I find is much more secure. I'm always worried about if the bank says to me, can you fill in this form and send it to me and my bank details and my signature. You know when you do a mandate ... like a direct debit ...*'

Information management (11/54)

'Managing information' was a theme that was also discussed extensively by all participants. This was due to the fact that information management is one of the fundamental academic functions. All interviewees had varying degrees of understanding and experience on managing information. The discussions gravitated towards three main topics: a) the use of online generic and specialist search engines, b) information authenticity, and c) teaching and learning practices. There were also some additional topics of interest such as open access to resources and publications, existing information-literacy skills, multimedia, and use of other information systems and apps. The majority of the interviewees mentioned extensive use of the Google search engine and the library website for academic resources, acknowledging the fact that significant skills are needed to distinguish among the appropriate search terms and filter the often vast amounts of results. Some of the participants mentioned the specific use of the Google Scholar search functionality when seeking for academic information, and that they actively tried to avoid Wikipedia, as it was not perceived as a reliable source. A small number of participants mentioned that sometimes they consult Wikipedia to get an idea about a topic and then they research it further by seeking authoritative sources of information. Two of the participants commented that books were thought to be somehow more trustworthy than information retrieved from the internet, but when they were asked to elaborate on their reasoning they failed to give convincing arguments. One student participant commented that they felt the use of books as a source of reference was an expectation for their degree projects and stated that, '*Books, I don't know … whilst I appreciate how long it takes to publish a book and the fact that it means the data isn't always necessarily you know the most up to date, I think they do still have slightly more grounding than … it feels like they've in this degree.*'

Unsurprisingly, the authenticity of information was discussed extensively by all participants in the context of ways to ensure that the sources were reliable and appropriate. Examples included the use of authoritative and established resources, such as websites of Professional, Statutory and Regulatory Bodies (PSRBs), and national and international resources from governments and other established international organisations. Participants also mentioned that they cross-reference information from a variety of sources and that they prefer specialist publications that have been peer-reviewed. Although most comments were related to academic practice, one of the administrators articulated the point of verifying and triangulating information in a different context by explaining that, '*I'm a bit sceptical about Googling things, because you're not entirely sure on the quality of the advice you're getting, and particularly with electronics you don't want to make a mistake because they're expensive. So I will go to set people who I know I can trust their advice, and if they don't know then I might go a bit further abroad.*'

Academics commented on how the development of information literacy and related academic skills were facilitated by giving guidelines, establishing recommended reading lists, explaining good academic practice and by developing the students' fact-finding and information-evaluation skills in general. One academic reported, '*... within the very first few days we start to explain to them "this is what is expected and this is the help and support you are going to receive to do this" and then follow it up very quickly with practical ways to do that and some of that may be really simple things like you spend a couple of hours in tutorial showing them on the screen on the wall the library web site and this is where the reference guide lives ...*' Most comments were academically related but a couple of the participants gave examples outside academic practices. Specifically, one member of staff commented on how they pursue information for the best financial deals and noted that, *'... if there's any ISA's or something coming to an end of a term, I then go on to the Internet and look to see who's offering what for the ISA's. So in actual fact, you don't feel that you've got to walk around the town or the high street, you can do it at a glance to see who's offering what.*'

Participants individually made some interesting comments on how they preferred open-access publications and articulated that the expected academic standards were often requiring them to use resources that were closed-access. They also discussed that they would rather use a variety of media as sources of information and that they generally were familiar with the use of online systems and mobile apps to access academic and non-academic information online. An academic member of staff with management responsibilities noted that information in the context of learning and teaching is wide-ranging and explained that, '*I get access to information systems say for example on student's assessments ... which hopefully enables you to be able to interpret and interrogate different information in relation to different metrics ... within sort of students' progress ... maybe attendance maybe attrition it maybe to do with a particular success or a particular assessment ...*'

General knowledge and functional skills (7/38)

The use of *'Manuals and instructions'* was another theme that emerged from the interviews. In particular, the participants' comments referred primarily to three broad categories: a) the use of manuals, b) the increasing trend of having manuals online rather than in print and c) their expectations from technology – to be simple enough to use without having to refer to instructions. Most of the participants stated that they do not often read the manuals, or when they do, they only skim-read or pick specific sections according to their perceived needs. One of the participants mentioned that they find themselves increasingly obliged to read the manual, as digital devices become increasingly complex, and stated that, *'... yeah, set things up and that sort of thing because everything is smart now isn't it like the telly, when you set the telly up if it's a smart telly so things like that yeah, I would do it, definitely ...'* A couple of participants reported that they do not use the manuals and find them confusing due to the fact that they do not understand the terminology. Another cluster of comments included observations concerning the trend manuals and instructions to be available only online, something that they perceived as problematic. An additional group of responses hinted the expectation that technology should become plug-and-play or, as a participant put it, '*No, they were just getting shorter and shorter I think the instructions. I don't know, I expected to just be able to plug it in and it will work but it's not quite like that, you have to link it up with whatever ...*'

Participants identified their *'General knowledge'* on digital technology in respect with their self-perceived generic digital-competences. A significant minority of the participants felt that they had sufficient skills and could cope with general technology use. They specifically mentioned that they had an inquisitive attitude and could generally '*work things out*'. One student in particular, reflecting on her development during her university time recounted, '*I think when I first joined this university about three years ago my skills were, to some extent, basic, if you see what I mean. As time went on, my skills started to develop more and more. But I think what I've found is that most of the computer technology or technology we have is easy to navigate, more or less. So even if you don't have some literacy before, it will take some time to find your way, but it's not as difficult as actually doing computing for the first time.*'

The vast majority of the participants had trouble identifying what *'Hardware and software'* meant in relation to digital technology. Most interviewees, when asked if they could identify what the software and hardware elements of their digital systems were, answered that they could not, with only one notable exception. One student participant replied, '*Depending on what the problem is. I've had various hardware problems with my previous laptop, so I've got used to taking it apart and replacing the motherboard and things. I've had to do that two times.*' A staff member responding to the same question noted, '*I suppose it's because I've got no interest, I don't want to know how it works, I want to use the computer to aid me to do my job and I couldn't live without it to do the job because of error rate and things like that, spell check and all those other bits but I am a bit naughty but if something goes wrong I tend to phone IT because I need them to sort it out, I don't want to know how it all works ...*'

Similarly, the vast majority of the participants, when asked to comment on their understanding of *'Operating Systems'*, revealed limited comprehension of the term. Although most of the participants had heard and recognised the term, they were unable to describe correctly what it meant. For example, a member of staff stated that, '*I would have thought different operating systems were like I use a database for student ... this is how I'm taking it. I use a database for student areas, Skyped to contact my son, Excel obviously to do the areas ... what else is there?*' A student participant, when asked to name any operating systems they knew, replied '*Microsoft Office and Linux*.'

Legal and ethical aspects (9/33)

Another theme was formulated by the interviewees' comments in the area of '*Legal and ethical implications of technology use'*. An awareness of the implications of copyright, and good academic and ethical practices, was observed by most of the participants. Examples of respecting intellectual property rights were discussed in relation to the implications of downloading from the Internet digital artefacts such as software, images, music and films. One academic, in particular, commented that within academia there is a specific function of evaluating and discussing ideas and other people's work, but this has to be done in an appropriate way by maintaining ethical and professional standards. He noted that, '... *obviously there is a huge ... focus on acknowledging intellectual property in terms of when you are referring to people's work ...*' Notably, an area that was important to a number of participants was privacy when using online technologies but also the detrimental misuses of technologies and the safeguarding of an individual's own personal space. The wide availability of audio-video recording technologies, manifested in the form of mobile technologies, and their potential to disseminate the recorded material instantly, raised questions on how they could be used ethically and safeguard against potential misuse that violated privacy. This was discussed in relation to legality with a number of participants feeling that their right to privacy was increasingly diminished. Crucially, they identified a need for establishing an etiquette of legal and ethical behaviour, especially when participating in open online spaces such as those provided by social networks for work or leisure. An academic explained that, '*... reminding everybody really about the importance of confidentiality and ... just making sure that ... when people communicate ... in whatever way they are going to communicate that involves any sort of application ... text or an email or Facebook or whatever ... that we reinforce from the very start some of the fundamentals that are, not just about being a student and a citizen but also the professional aspects as well ... the absolute importance of ... of things like patient confidentiality that people realise ... they understand when they are sending information that they are very aware of ... who is going to receive it ... seen, heard by people that shouldn't be seeing it ...*'

Understanding and awareness of the role of ICT in society (8/20)

'Social issues' arising from the use of technology was another theme commented on by the participants. One of the raised concerns was potential job losses due to increasing utilisation of technology. The introduction of self-service machines at the supermarket check-outs was highlighted as a recent example of machines replacing people. Transformation of our socialisation and communication patterns was also raised as a concern due to the increasing penetration of technology into our everyday lives. People tend to spend less time engaging in social interactions with their families, as technology is sometimes easier to engage with, and it is often used as a techno-nanny. An academic recounted how inadvertently they have overlooked spending time with their child because of the convenience of digital technology, and explained that, '*So I think using Smartphones transformed the way we actually socialise and communicate, and it's created new challenges for you and how you spend this time with your family sometimes. In fact, my wife told me, "You spend less time with our child," because I give him the phone and she said, "Your child is playing alone. Can you make sure you play with him and spend more time?" So I try to use self-discipline and designate more time to my child, really.*' Technology can divert the attention of an individual as the influx of information can be distracting and, for some, time-wasting. Certain technologies have

become a status symbol and some of them, marketed as lifestyle accessories, are particularly attractive to a wide audience.

Instances of online bullying and harassment sometimes have devastating effects upon the lives of people. In some unfortunate cases these have escalated and resulted in self-harming or even suicide. People through the use of online digital platforms can sometimes exercise control and inflict abuse, even without physical confrontation, through the use of technology. A student participant sensitive to this issue reported that, '*People hide behind keyboards. I've known so many arguments over the years of people who go to school with each other on line because it's about you're not physically there with the person and so in reality you know you would be in a fight with that person if you told them this, it's avoiding confrontation, people don't actually have to deal with what they've done a lot of the time. So I think if you get things like trolls, I think it's a dissociative problem that they've developed by being too influenced by technology most probably a lot of it ...*' These problems have not been instigated by technology but they transform and magnify existing social phenomena into technology-facilitated manifestations.

'Technology and the environment' was a theme that was mentioned by the minority of the participants and was discussed within the context of three main areas: a) saving trees by reducing paper usage, b) reducing energy consumption, and c) appropriate electronic-waste disposal. The most prominent theme was that of reducing paper use through the utilisation of digital technologies. Examples included the use of digital technologies for distributing and archiving documents in electronic forms, such as lecture handouts and other learning material. A student noticed a change in their own practice and stated that, '*… it has an environmental implication and it does make it easier to sort of archive things because obviously with the paper you know, you will end up with stacks and stacks of paper.*' An academic observed that the introduction of an e-assessment system brought significant environmental benefits, improved the processes, and enhanced the student experience. They reflected that, '*... for me the whole neatness of actually getting things handed in, being able to look at work, being able to comment on it and get it assessed and you can do all that online rather having to carry bundles of paper around.*' Three interviewees mentioned the impact of using digital technologies on power consumption and noted that the energy-saving functionality, built into most modern digital devices, was often used as a key-selling point when marketing products or services. The electronic-waste disposal was also another issue

raised by a couple of the participants with one of them having a particular issue with the apparent, built-in, obsolescence of digital devices that tend to require replacement even if they are fully working. The result of this tendency is unnecessary waste. They observed that, *'... they just get rid of I don't know, they just get rid of so ... it's out of warranty, get rid of it and you think but that's fine, there's nothing wrong with that, maybe you just need to reinstall whatever on it ...*'.

4.1.3 Remapping the Themes to the DigComp$_{v1}$ Framework

At the time of conducting the interviews the DigComp framework was still under development with only the preliminary results of the DigComp$_{v0}$ conceptualisations publicised in the public domain (Janssen and Stoyanov, 2012). Since the EU Joint Research Centre Institute for Prospective Technological Studies (JRC IPTS) published the first version of the DigComp$_{v1}$ framework (Ferrari, 2013), the qualitative analysis of the interview results had to be re-evaluated against the new taxonomy. For purposes of aligning the results and analysis, the interview themes were reallocated to the digital literacy areas of the DigComp$_{v1}$ version of the framework [ACTION_05]. The main difference between the initial classifications of the DigComp$_{v0}$ and those of the 2013 DigComp$_{v1}$ version of the framework was the reduction of the digital-literacy areas. A number of the areas and competences of the DigComp$_{v0}$ were included as sub-themes in DigComp$_{v1}$, while others had been removed altogether. In particular, the DigComp$_{v1}$ version comprised of five digital-literacy areas: Information, Communication, Content Creation, Safety, and Problem Solving (Ferrari, 2013).

DigComp$_{v1}$ Competence Area	Definition
Information	identification, retrieval, storage, organisation, analysis of digital information and purposeful evaluation for a specific use
Communication	communicating, sharing resources, linking and collaborating, interacting, facilitating cross-cultural awareness and participating in communities and networks by the utilisation of digital technologies
Content Creation	creating and editing of multimedia content, appropriating and remixing of existing content, producing creative expressions such as media artefacts and programming, dealing with and applying intellectual property rights and licensing
Safety	protecting of personal information, including digital identity and data, the taking of security measures in the digital environment and safety, and sustainability when using digital technologies
Problem Solving	identification of digital needs and resources, making of informed decisions on digital tools, solving of problems through the utilisation of digital technologies, the creative use of technologies, solving of technical problems and the updating of one's own and others' digital competences

Table 8 - The DigComp$_{v1}$ Digital Literacy Area Definitions

The DigComp$_{v1}$ digital-literacy area definitions as described in DigComp: A Framework for Developing and Understanding Digital Competence in Europe (Ferrari, 2013).

Based on these definitions the twenty-two themes that arose from the interviews were remapped to the $DigComp_{v1}$ framework digital-literacy areas. Eight themes did not match the definitions and were excluded from remapping onto the $DigComp_{v1}$ taxonomy. Three of the excluded themes (Technology Use, Digital Devices and General Knowledge) deemed to be too broad, and the remaining five (Technology Use Barriers, Specialist Digital Skills, Online Banking, Social Issues, and Operating Systems) too narrow to be categorised under the $DigComp_{v1}$ classifications. The digital literacy areas and the competences can be found on the left-hand side of Table 9 while the themes that arose from coding the interview data can be seen on the right-hand side of the table.

A notable feature that was observed while analysing the comments of the interview participants on the various areas of the digital-literacy framework was that their examples were always related to specific technologies, or to the participants' individual attitudes and experiences. For example, while describing the use of a digital-content creation system, they always named the technology (e.g. Word, Prezi, PowerPoint etc.) and never referred to it as a word processor or presentation software. Similarly, when commenting on social networks, they always named the technological platform (e.g. Facebook, Twitter, etc.) and never referred to it as a social network. This type of analysis belongs to semantics. Nevertheless, it is important to recognise that the manifestation of this phenomenon is due to some underlying reasons. Exploring this insight further one could theorise that participants do not necessarily develop a wider understanding of the terminology concerning technologies but only identify specific technological systems or platforms that could be used to meet their goals and achieve specific outputs. These observations reinforced the perception that participants were not readily able to discuss their technological capabilities in an abstract way, but only articulate them via concrete examples they had explicitly experienced.

DigComp_{v1} Areas and Competences	Interview Themes Mapping
1. Information (11/140)	
1.1 Browsing, searching and filtering information	- Technology use in education (9/86)
1.2 Evaluating information	- Information management (11/54)
1.3 Storing and retrieving information	
2. Communication (11/89)	
2.1 Interacting through technologies	- Communication and collaboration (10/43)
2.2 Sharing information and content	- Social networks and media (11/37)
2.3 Engaging in online citizenship	- Communities of practice (5/9)
2.4 Collaborating through digital channels	
2.5 Netiquette	
2.6 Managing digital identity	
3. Content creation (11/55)	
3.1 Developing content	- Legal and ethical aspects (9/33)
3.2 Integrating and re-elaborating	- Content authoring and remixing (11/22)
3.3 Copyright and licences	
3.4 Programming	
4. Safety (11/140)	
4.1 Protecting devices	- Balanced use of technology (10/76)
4.2 Protecting personal data	- Security and privacy (11/55)
4.3 Protecting health	- Technology and the environment (4/9)
4.4 Protecting the environment	
5. Problem solving (11/122)	
5.1 Solving technical problems	- Learning skills and support (11/85)
5.2 Identifying needs and technological responses	- Manuals and instructions (7/16)
5.3 Innovating and creatively using technology	- Learning about new technologies (6/12)
5.4 Identifying digital competence gaps	- Hardware and software (7/9)

Table 9 - Interview Themes Mapped onto the DigComp_{v1} Framework Areas

The interview themes remapped on the DigComp_{v1} digital-literacy areas. The first number within the brackets denotes the number of participants that mentioned a theme, and the second denotes the number of references.

It is also important to note that digital literacy in general, and consequently both versions of the DigComp framework, presented a high degree of overlapping within their classification areas. This is because digital literacy, as articulated earlier in this work, is an abstract concept depicting the digital manifestation of a number of overlapping skills, cognitive qualities and individual attitudes. A view shared among the authors of both versions of the DigComp framework was also explored in this thesis (Janssen and Stoyanov, 2012; Ferrari, 2013). While examining the content of the excluded themes it was observed that, although they offer valuable insights on how digital capabilities manifest, they do this via very specific examples not useful in defining a generic framework that must be abstracted and used as a universal tool to describe digital literacy. These findings support the decision of the authors to exclude or merge areas arising from the initial results of the early DigComp$_{v0}$ formulation from the DigComp$_{v1}$ version published in 2013, although the rationale for excluding these themes was not explicitly mentioned in the literature (Ferrari, 2012, 2013; Janssen et al., 2013). The residue of filtering and reclassification of the data was the fourteen (14) remaining interview themes that were further explored in the latter part of the discussion that follows.

4.1.4 Discussion of the Interview Themes in relation to the DigComp$_{v0, v1}$ Framework Areas

In general, the structure of the DigComp$_{v0}$ framework organised in the twelve digital literacy areas (see: Table 7) has proved very accommodating and flexible and could be used to categorise a diverse array of experiences. However, a closer examination of the coded themes, arising from the interview data, reveals that ‘Informed decisions on appropriate digital technologies’ and ‘Seamless use demonstrating self-efficacy’ were DigComp$_{v0}$ digital-literacy areas that were not discussed by any of the participants. Therefore, they were considered as inappropriate descriptors of digital literacy since participants could not identify with them, or give any examples coherent with their experiences. The total numbers of individuals commenting on a theme, and the number of references made, are ranked in Figure 13 for each high-level digital-literacy area.

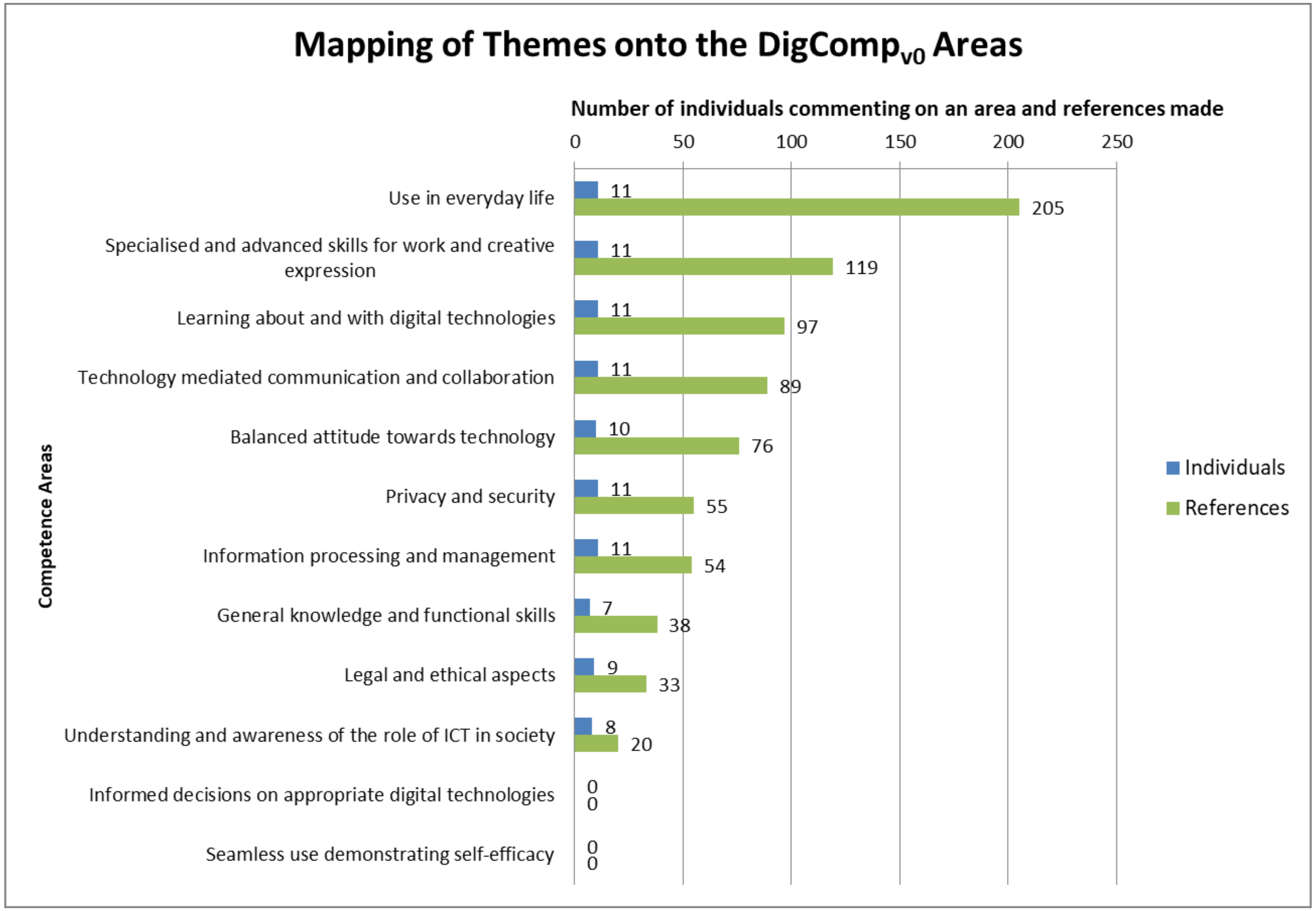


Figure 13 - Mapping of Themes onto the DigComp$_{v0}$ Areas

The interview themes mapped on the DigComp$_{v0}$ digital-literacy areas. The number of individuals and the number of references are identified for each digital-literacy area.

The first five areas identified at the top of Figure 13 are considered to be the most significant and they have been deliberated extensively by the participants exhibiting an above-average number of references when compared to the average number across all themes. The framework area that received the majority of references was that of ‘Use in everyday life’. This was because it reflected a variety of comments related to examples of how participants used technologies, and technology-use barriers, including some specific discussion around electronic banking and payments. This category included all relevant comments that were of interest and could not be explicitly associated with any of the other digital-literacy areas. One significant reason that contributed to this apparent behaviour was that participants were drawing from a variety of experiences based on their individual backgrounds, and were focusing on their individual areas of interest rather than expressing views that fitted the pre-determined conceptualisations of the framework.

The second most prevalent area of discussion was that of ‘Specialised and advanced skills for work and creative expression’. Its main focus was on specific examples of how technology was used within education and, to a lesser extent, on how digital technologies have been used specifically to author digital content and for achieving other specialist outcomes. The comments suggested that participants exhibit a very practical approach to using technology and this was always articulated within the context of achieving some specific outcome. Another important area of discussion was that of ‘Learning about and with digital technologies’ where participants reported on their experiences of learning how to use new digital technologies. This theme was again strongly linked to applied examples with participants drawing mostly from their experiences of learning about, rather than with, new technologies and seeking support whenever things went wrong. The area of ‘Technology mediated communication and collaboration’ was a focal point of discussion in the context of using digital technologies to communicate, the use of social networks, and the formation of technology-mediated communities of practice. Participants also mentioned that in some cases they specifically used technologies as enablers for working and collaborating at a distance. An area of discussion that was surprisingly popular was that of ‘Balanced attitude towards technology’, a theme that included a large number of comments of participants reflecting on the advantages and drawbacks of using digital technologies. This topic was initially thought of as problematic as it was considered to be rather vague. However, participants readily commented on their perceptions on the social implications of technological progress with some of them exhibiting strong views on the advantages and disadvantages digital advancements have brought upon society.

Secondary digital-literacy areas have been classified as those that have attracted a number of references below the average number across all themes. The ‘Privacy and security’ area was of interest. Most of the participants revealed they were aware of the need to protect themselves and their devices from misuse and other malicious attacks. Managing information in the digital domain and ensuring trustworthiness within the context of ‘Information processing and management’ was also discussed. The arguments for information authenticity were a fundamental theme in this area, as they constituted one of the essential elements of academia and education in general. ‘General knowledge and functional skills’ was an area of discussion that was also proven very interesting. It was expected to attract a large number of comments and extensive discussion but it has been primarily deliberated in the context of using manuals and instructions, and the participants demonstrated widely divergent habits when trying to find out suitable ways to make use of the technologies at their disposal.

In contrast to the areas previously discussed, the areas of ‘General knowledge’, ‘Hardware and software’ and ‘Operating systems’ did not attract many comments as the participants were unfamiliar with them. Another area that has not attracted a large amount of comments, but seemed to be fairly important to the participants as it was demonstrated by the nature of the discussions that were specific and concise, was the ‘Legal and ethical aspects’ of technology use. The participants commenting on this area recounted examples of the values, legal and ethical considerations, and expected behaviours existing within the healthcare discipline. This was attributed to the inclusion of such topics in the taught curriculum. The least discussed area of the framework was this of ‘Understanding and awareness of the role of ICT in society’. It has been commented on only by a small number of participants. Nevertheless, the participants that cared to comment on these issues had some strong views to contribute on the impact of digital technology upon the environment, and upon society in general.

An evaluation of the relative importance of the themes arising from the interview data, according to the structure of the revised DigComp$_{v1}$ framework, is illustrated in Figure 14.

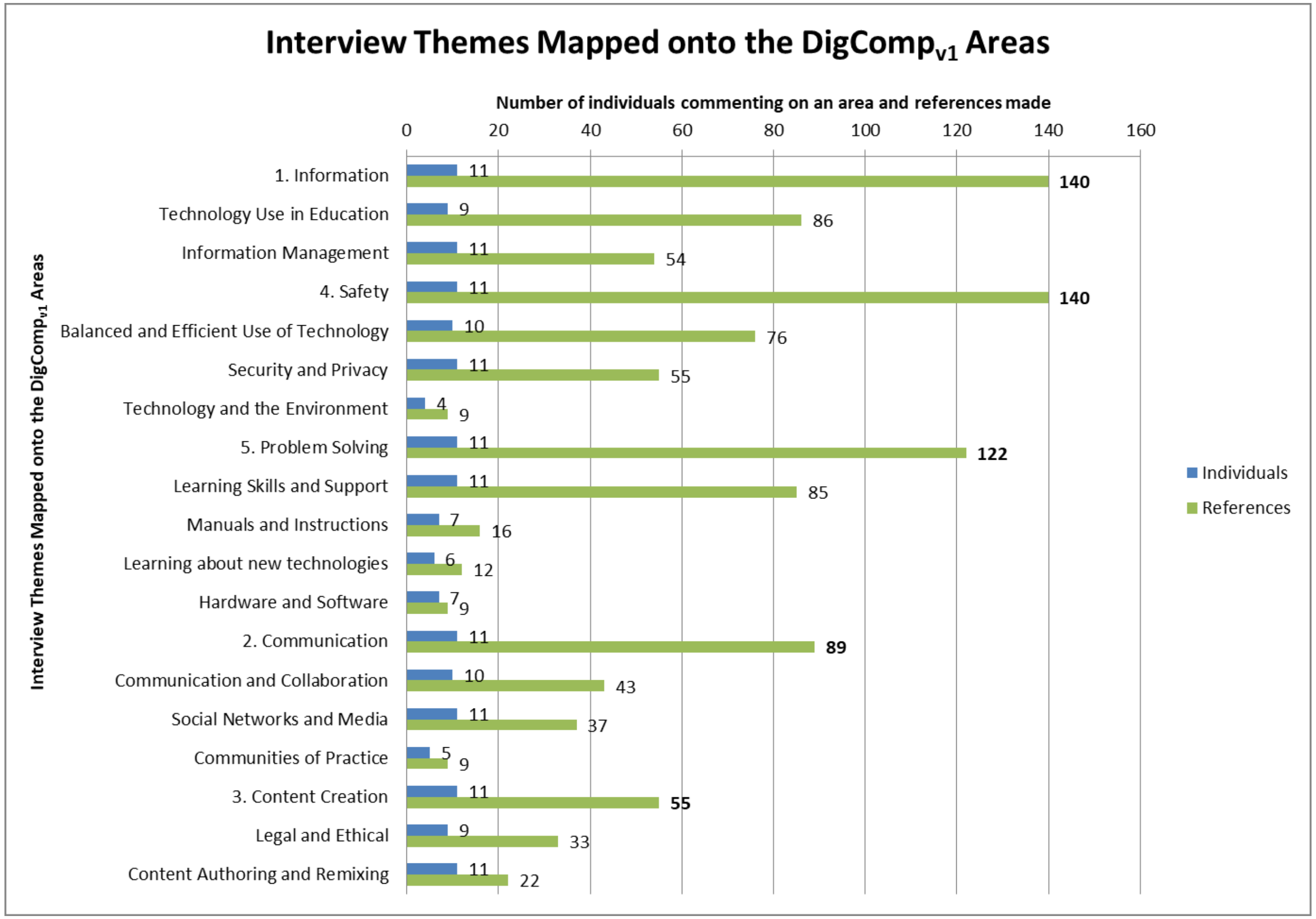


Figure 14 - Interview Themes Mapped onto the DigComp$_{v1}$ Framework Areas

The interview themes mapped on the DigComp$_{v1}$ digital-literacy areas. The number of individuals and the number of references are identified for each theme and digital-literacy area.

The most prominent digital-literacy areas were those of 'Information', 'Safety' and 'Problem Solving'. In contrast, the areas of 'Communication' and 'Content Creation' attracted fewer comments and for this reason they were perceived to be less pronounced. It should be noted that the observed behaviour was based on the views of the interview participants and it does not imply that these areas are less important in absolute terms when evaluating the framework. It indicates, however, that the participants' experiences, as a group, did not associate with these digital-literacy areas to the same extent. For this reason the findings will be explored in the context of the shared characteristics of the participants who were all key stakeholders of healthcare education internal to the institution. Predictably, the attributes of the group indicated a strong association with their academic-related identities with the areas of 'Information' and 'Problem Solving' featuring prominently. It was also noticeable that the group, as a whole, was highly sensitive to matters concerning 'Safety' and 'Security and Privacy'. This observed characteristic could be attributed to the professional identity of the group relating to healthcare education that is permeated by strict safety and ethical codes of conduct, and a disposition to nurture compassionate behaviour. Since the interviewee group comprised of students, academics and academic-related professionals it was also considered as pertinent to summarise their views separately.

Students reported examples of technology-use drawing from the use of the Virtual Learning Environment (VLE), digital information management systems provided by the library services, the extensive use of information searching on the World Wide Web, and the creative use of a variety of other technologies to complete their assessments, including the use of multimedia in presentations. Reflecting on the experiences of technology use in their personal lives they reported extensive use of technologies such as online audio-video conferencing, instant messaging and social networks to communicate with family and friends. Encouragingly, most of the students were aware of the risks involved when using technologies and of the Internet in particular. However, they were not confident in their ability to protect themselves from potential threats. They considered themselves to be proficient in the use of technologies but, when asked to describe the types of their digital engagement, most reported high engagement only with a small number of digital technologies such as mobile devices and social networks. This result was of particular interest as this type of technology-user is difficult to engage since they do not recognise the need for further development.

Academics were primarily preoccupied with the impact of technologies used for work in their daily lives. Examples of how the pervasive use of mobile technologies created the expectation of being accessible outside their working hours often led to an increase of their stress levels, due to the influx of work-related information on their private devices. Although they generally welcomed the increased use of technologies in education and pointed out that when it is used appropriately it can enhance the student experience, they pointed out that the ownership of digital devices was not universal. They also emphasised that some students were generally disengaged from technologies and felt that engaging them in technology-mediated activities could be challenging. Nevertheless, they agreed that exposure to technology and development of digital skills was beneficial for all students. They also suggested that disengaged students would benefit the most if technologies were used within groups as these students could be peer-supported.

Academic-related professionals reported the regular use of a wider variety of technologies in their work and private lives. Their experiences were similar to those reported by the academics and to some degree with those of the students. They had a positive attitude towards technology and they understood its use, in particular the use of institutional systems, was an intrinsic part of their roles. They also described examples of daily technology-use that were more complex in comparison to those offered by the academics and students. Unlike the academics, they generally welcomed policies and protocols around the use of institutional systems as these were perceived to be making their work easier, whilst the academics portrayed the same process as restrictive and bureaucratic. Regarding the acquisition of more advanced technological skills, it was suggested these were acquired on-demand, or when required by the business workflow.

4.1.5 Conclusion

The first set of actions [ACTIONS_01 & 05] aimed to investigate the appropriateness of the DigComp digital-literacy framework and describe how the main stakeholders of healthcare education within the institution (students, academics and academic-related professionals) perceived digital literacy. This was the first step in answering the first research question and evaluating if digital-literacy frameworks could be used to support student learning. A secondary question, investigating the existence of any disciplinary-specific, digital-literacy characteristics in healthcare education, was also appraised. The interviews identified significant themes resulting from the views, attitudes, skills and practices of the interviewees. Mapping of these themes on the digital-literacy taxonomies of the $DigComp_{v0}$ and $DigComp_{v1}$ versions of the framework showed that they could be used to describe the participants' experiences in generic, abstracted terms. The data, however, showed that digital-literacy characteristics of the individuals were highly personalised as affected by the individual's experiences. The early results of the $DigComp_{v0}$ consultation included a number of areas that elucidated a large number of skill-specific answers, thus indicating that the early structure was not optimised to become an abstract framework suitable for the description of digital literacy in a variety of circumstances. This was supported by the findings that identified two areas the participants were unfamiliar with, and could not offer any examples deriving from their experiences. Additionally, when the themes were remapped on the digital-literacy framework areas of the $DigComp_{v1}$ version, a number of themes that arose from the interview data could not be directly matched to the digital-literacy areas. The data resulting from the qualitative analysis carried out in this thesis supported the decision of the $DigComp_{v1}$ framework authors to revise the structure that resulted from the $DigComp_{v0}$ consultation version and summarise the digital competencies under five high-level areas, rather than the twelve original ones.

In conclusion, the qualitative analysis of the interview data showed that the framework was appropriate to adequately describe the digital qualities and capabilities of the participants. Evidence for the appropriateness of the $DigComp_{v1}$ version was found in the fact that there were no high-level, digital-literacy areas that had not been sufficiently commented by the interview participants, and in the fact that all the interview data, when coded, could be classified under the existing $DigComp_{v1}$ areas. Although some characteristics, uncovered through this qualitative analysis, have been speculatively linked to the disciplinary ethos and context, there was no conclusive evidence that any of the digital-literacy qualities, or competences were unique to healthcare education. Specification of healthcare-specific, digital-literacy characteristics may not be possible as, quite often, technology is used pervasively and interchangeably across education, work and leisure.

4.2 Intervention 2 (Actions 2-4): Embedding Digital Literacy in the Curriculum

Having established that the DigComp$_{v0}$ framework (Janssen and Stoyanov, 2012) could be used to describe digital literacy in healthcare education, Intervention 2 was designed to investigate research question 2. The aim was to explore the ways that a framework approach could be used to understand how digital literacy manifests in student learning experiences, and how it can be developed in a higher education healthcare environment. Utilising the early formulation of the DigComp$_{v0}$ framework flexibly, a self-assessment questionnaire was developed aiming to establish appropriate metrics for quantifying digital literacy. Following the Learning Design (Dalziel et al., 2013) approach the framework was also used to structure a number of technology-enhanced learning activities and thus embed digital literacy in the curriculum. The student experience was investigated by qualitatively analysing the views of students recorded in reflective diaries and through focus groups.

The learning design approach to curriculum development, founded on the premises of technology-enhanced, activity-based learning (Goodyear, 2001), was employed to embed digital skills within the existing study programme due to the nature of digital literacy and the delivery mode of the module. This was because there was evidence in the literature (Leeds Metropolitan University, 2011; Joint Information Systems Committee (JISC), 2013; Thomson et al., 2014) that digital skills are best developed in the context of the existing disciplinary curriculum and should not be offered as a separate training course which students find difficult to relate to and incorporate into their already busy workloads. The activities were designed to deliver aspects of the existing curriculum and, at the same time, introduce digital-literacy elements identified by the DigComp$_{v0}$ framework. These were delivered online via the institutional Virtual Learning Environment (VLE).

4.2.1 Methods

The intervention was applied to the first study module of an incoming Midwifery cohort as the schedule of the delivery was suitable and the teaching team was willing to experiment with this technology-enhanced, learning-design approach. The selection of a first-year module was considered as advantageous since it alleviated concerns around student preconceptions of what a typical curriculum-delivery should entail. The module was delivered in two different geographical locations by a number of tutors under the co-ordination of the module leader. Due to restrictions imposed by the institutional quality-assurance processes the online activities were offered in addition to the scheduled content of the module via the institutional VLE. These technology-enhanced study activities were structured according to Salmon's (2002) 'e-tivity' model.

Specifically, the activities included the completion of a digital-literacy self-assessment questionnaire [TOOL_01], six learning designs, with the last activity evaluating the student experience through short, reflective diaries. These were offered to all first-year Midwifery students ($n = 102$) undertaking the module. The first activity, requiring the students to complete the self-assessment questionnaire, was administered via the Survey Monkey online survey platform, and was completed by all of the participants. The six activities that followed were designed to enhance the digital literacy of students by requiring them to undertake simple, technology-mediated tasks based on the disciplinary content of the module. These activities articulated tasks that required the students to use a variety of digital skills to research, compile and present information in the digital domain. The last activity, which required the students to report on their experience of developing their digital literacy by undertaking these activities, was completed by (19%) of the participants. The quantitative analysis of the questionnaire results was carried out through the use of the Microsoft Excel 2010 spreadsheet software including the Real Statistics (release 4.12.1) plugin (Zaiontz, 2013a). A grid of the mapping of the eight e-tivities against the twelve digital-literacy areas of the $DigComp_{v0}$ framework can be seen in Table 10.

E-Tivity / Digital Competence	1	2	3	4	5	6	7	8
1. General knowledge and functional skills	✓							✓
2. Use in everyday life								
3. Specialised and advanced skills for work and creative expression				✓				
4. Technology mediated communication and collaboration						✓		
5. Information processing and management			✓					
6. Privacy and security								
7. Legal and ethical aspects								
8. Balanced attitude towards technology								
9. Understanding and awareness of the role of ICT in society								
10. Learning about and with digital technologies					✓			
11. Informed decisions on appropriate digital technologies							✓	
12. Seamless use demonstrating self-efficacy		✓						

Table 10 - E-tivities Mapped against the DigComp$_{v0}$ Framework Digital Literacy Areas

The E-tivities (horizontally) mapped against the DigComp$_{v0}$ digital-literacy areas (vertically). It should be noted that, although it was originally envisaged all digital-literacy areas to be covered within the activities, it was decided to have a smaller number of technology-enhanced activities suitable for the curriculum context rather than a large number or fairly complex activities.

The impact of these online-learning activities upon the student experience was explored by conducting two focus groups, one for each location. These were attended by $(n = 32)$ students, corresponding to participation rate of (31%). A semi-structured approach was used when conducting the focus groups whereby a presentation with questions, prompting the students to elicit answers, was projected on a screen to maintain concentration on the key questions. The students were encouraged to comment freely, and expand to any other relevant areas they considered as important. The discussions within the focus groups were recorded and transcribed, producing a corpus of 24,783 words. The transcribed text was analysed through the use of QSR NVivo software (QSR International Pty Ltd, 2017) by coding the transcribed text and the reflective diaries into themes, following the coding recommendations by Miles and Huberman (1994) and Guest et al (2012).

4.2.2 Developing and Evaluating the Digital Literacy Self-assessment Questionnaire

The purpose of creating the self-assessment questionnaire was to investigate a method for quantifying the digital literacy of students and assess its appropriateness as a tool that could quantify the digital-literacy characteristics of individuals and groups. In particular, the questionnaire focused at evaluating the attitudes of students towards the various types of digital engagement by examining a snapshot of the digital-literacy potential of the participants. This bespoke self-assessment questionnaire tool [TOOL_01] was developed on the basis of the DigComp$_{v0}$ framework taxonomy (Janssen and Stoyanov, 2012). This early version of the framework was formulated by an iterative mixed-methods Delphi-type survey, which recorded the views of 95 international experts. The experts were asked to identify the attitudes, knowledge and skills that constituted digital literacy in research, education, training and work. The expert participants had been asked to generate ideas by completing the phrase starting with, '*A digitally competent person is someone who...*' (Janssen and Stoyanov, 2012, p. 3). They were also asked to prioritise the unique answers and corroborate them as a group. This resulted in identifying twelve high-level concepts describing digital literacy that were further elaborated by five example statements per digital-literacy area. The examples had been selected from a wider variety expressed by the experts on the basis of the highest average scores when rated against their relevancy to an individual. The experts had been asked to rate the exemplar statements on a scale describing the importance of knowledge, skills and attitudes identified in the statements for individuals within the population. They were denoted as most, some, few, or not at all during the validation stage. As a result of this process a holistic view of what constituted digital literacy was defined.

These statements, articulated by the experts, were used to formulate the questions of the digital-literacy, self-assessment tool. The clusters of five statements were transformed into clusters of five questions defining a Likert-type scale (Likert, 1932) that was to quantify the underlying concepts of each high-level, digital-literacy area. A six-point response format was used to allow the participants to self-evaluate their digital literacy by agreeing or disagreeing with each statement. The six-point response format was considered as an acceptable solution in balancing the requirement for some degree of fine-grading, against ensuring meaningful responses (Carifio and Perla, 2007). The six-point response format included the options of: strongly agree, agree, agree somewhat, disagree somewhat, disagree, and strongly disagree. There was also the option of 'no response' to allow participants to explicitly indicate a desire for not responding. The response format was symmetrical with half of the options indicating agreement with the statement and the other half indicating disagreement. This symmetrical response format did not include a middle point to encourage the participants to make a conscious choice and disallow them to linger near the middle without committing to a decision, since this attitude has been described as an inherent tendency when response formats of this type are used (Salkind, 2010). An additional section capturing information on their gender, age, ethnicity, household income, educational qualifications and employment status was included in the pilot questionnaire to capture the demographic details of the sample group. An example of a question cluster can be seen in Figure 15. The full questionnaire can be found in Appendix - TOOL_01 Questionnaire DigComp$_{v0}$. The analysis that follows was conducted in respect to the performance of the tool and its potential applicability in establishing quantitative measures of digital literacy that could be utilised within a model for embedding digital literacy into the curriculum design and delivery.

***8. General knowledge and functional skills**

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I am able to use a digital device, which may be one of many types (e.g. Desktop PC, Laptop, Tablet, Smart phone).							
I possess general computer skills (typing, using computers, getting into a new programme).							
I understand the difference between hardware and software.							
I am familiar with the meaning of terms commonly used in user manuals for the operation of hardware and the installation and configuration of software.							
I know about the existence of various operating systems.							

Figure 15 - General Knowledge and Functional Skills

An example of a question-cluster for the DigComp$_{v0}$ digital-literacy area General Knowledge and Functional Skills. The statements had been articulated by the expert group during the DigComp$_{v0}$ framework consultation (Janssen and Stoyanov, 2012) and were used to formulate the questions of the digital-literacy self-assessment tool. A six-point response format with an additional 'No response' option was used to allow the participants to self-evaluate their digital literacy by agreeing or disagreeing with each statement.

4.2.2.1 Sample

The sample ($n = 102$) was primarily constituted of white British (91%), female (95%), young adults (76%) under the age of 35. About three quarters (74%) reported an average to low household income of less than £50,000 per annum. Just over three quarters (76%) of the participants were qualified at, or below, diploma level, prior to commencing their undergraduate degree. Almost three quarters of the participants (74%) reported that they were not employed. The demographics are illustrated in Figure 16.

This demographic profile cannot clearly be considered as representative of the general population as a total, although it could be considered as reasonably representative of the typical healthcare cohorts within the faculty. The main objective for constructing and issuing the questionnaire was the establishing of a baseline of the digital-literacy characteristics of the participants as a group. As this was the first attempt in administering the questionnaire and the sample was not representative of the population as a total, it was decided not to attempt any inferences or generalisations in respect to the wider population and, as such, the analysis was limited in evaluating the usability, and in exploring the validity of the tool. In the light of these constraints it was established that the sample, or the group of participants, could be considered to be representative of the healthcare student population.

Figure 16 - Questionnaire Demographics DigComp$_{v0}$

The DigComp$_{v0}$ questionnaire demographics illustrate the sample (n=102) characteristics in terms of A. Gender, B. Age Range, C. Ethnicity, D. Household Income, E. Education and F. Employment Status.

4.2.2.2 The Self-assessment Scale of the Questionnaire Tool based on DigComp$_{v0}$

Critical discussion on the theory of using Likert-type data, warns about being cautious in ensuring that the correct types of analysis are used in respect to the collected data sets (Michell, 1986; Jamieson, 2004; McCrum-Gardner, 2008; Lantz, 2013). Measuring attitudes by using a range of predetermined responses to a question or statement within a pre-constructed hierarchy, produces ranked, ordinal data, but does not necessarily guarantee that the intervals between the responses are equivalent (Blaikie, 2003; Hansen, 2003). The assumptions of equidistance and normality are important as they are pre-requisites for the legitimate use of parametric statistical methods and should not be used for ordinal-type observations. When these assumptions could not be satisfactorily met, non-parametric statistical methods could be used to analyse the data sets and interpret the results.

However, the importance of the assumption of equidistance and the possibility of using parametric statistics to analyse data arising from Likert-type scales is fiercely supported by Carifio and Perla (2007). They make an important distinction between a Likert scale and a Likert response format arguing that, under certain conditions, a Likert scale can produce interval-type data but also, as Glass, Peckham and Sanders (1972) have shown, many parametric tests are very robust and not susceptible to the lack of equidistant responses. Another important point that Carifio and Perla (2007, p.4) make stems from wider methodological assumptions, and is that '*scale items are not autonomous and independent … but rather they are a structured and reasoned whole … which also meet certain empirical criteria as well as logical and content criteria.*' Therefore, it is important that the results of the scale are considered in the analysis, and not the responses to the individual items that constitute the scale. A final point for consideration is that, when using ordinal or interval scales, it is not possible to interpret how many interventions it will take to move a respondent's response from one item to the next on the response scale. Thus, the same procedural restrictions apply equally to both, ordinal and interval data, if the analysis is carried out with respect to causal links from actions to measured behaviours.

The purpose of this questionnaire was to investigate the potential and limits of base-lining the digital literacy of the participants, not to draw assumptions about the general population, nor to measure the effect of interventions. For these reasons, the use of descriptive and non-parametric methods of statistical analysis was deemed to be adequate. The main objective in this early attempt to quantify digital literacy was to devise a robust tool that could identify the digital capabilities of individuals and not to optimise the tool for sensitivity and precision.

4.2.2.3 Validity of the Tool

The consensus in psychometric evaluation and test theory is that there are two main issues when using questionnaires as measurement tools: validity and reliability (Gandek and Ware, 1998; Grogan et al., 2000; Cohen, Manion and Morrison, 2007; Lavrakas, 2008; Elkin, 2011; Brace, 2013). Validity can be determined generally as the extent of conformity between the observed measurement and reality. In the context of psychometric evaluation by utilisation of a questionnaire instrument, validity can further be examined in terms of the content, criteria and constructs. Content validation is the process of determining whether the questionnaire contains the necessary questions to answer the research question or hypothesis. The questionnaire was based on the structure and definitions of the DigComp$_{v0}$ (Janssen and Stoyanov, 2012) framework that has been validated by international experts participating in the Delphi study, as it has previously been reported. Criteria validity refers to the degree of correlation among the results of the instrument and predetermined standards of previous studies. As the underlying concept of digital literacy and the framework were under development at the time of conducting the intervention, there were no prior studies that could have been used as a benchmark, or criteria, other than the publications relevant to the development of the DigComp framework.

At the time of writing this thesis there were not widely established tests for measuring digital literacy which could be considered as established standards, although currently there are promising national (Joint Information Systems Committee (JISC), 2017c) and international assessment tools in development (Vuorikari, Punie, Carretero and Brande, 2016). Construct validity is evaluated by the extent the questionnaire determines the underlying concept, theory and hypotheses. The purpose of the questionnaire was to quantify the digital literacy of the participants and not to make any inferences, or test a hypothesis about the wider population. Thus, the construct validity coincided with the concept criteria of validity and reliability.

When examining the reliability of the research instrument, the internal consistency of the questions and the consistency of the results deriving from issuing and re-testing the instrument have been taken into consideration. Internal consistency, in terms of the tool reliability, is defined as the degree to which items on a scale are consistent or correlated with one another. In psychometric testing this has often been interpreted to represent the extent to which a scale quantifies a concept. A common statistical measure used to quantify the internal consistency of a scale and evaluate the reliability of an instrument is coefficient alpha or, as otherwise it is known as Cronbach's alpha (Cronbach, 1951). Cronbach's coefficient can be used to approximate the reliability of a questionnaire instrument from a single survey occurrence based on the associations of the question items (Goforth, 2015). However, other work has identified that the interpretation of the results merits careful consideration as the coefficient can only directly determine the consistency of the responses (Cronbach and Shavelson, 2004; Webb, Shavelson and Haertel, 2006).

For these reasons, if the Cronbach coefficient was to be utilised as a measure of the internal consistency of a psychometric questionnaire-instrument, the assumptions of uni-dimensionality (Cortina, 1993) and the 'essential tau-equivalence' (Miller, 1995) had to be met. A uni-dimensional scale measures a single latent construct, whereby the essential tau-equivalence means that every item measures the same underlying variable, on an equivalent scale which, however, allows for variability in the degrees of precision. Therefore, the tau-equivalent model allows for diverse error variances (Graham, 2006). Consequently, it is important to explore if the instrument measured the same latent trait on the same scale, which was explored by conducting a factor analysis.

4.2.2.4 Treating No Responses

Prior to carrying out a further analysis of the results, all individuals that chose not to respond to any question within the scales were removed from the dataset. Otherwise, the results could be skewed by an artificial increase in volatility of the measurements within the scales. This was confirmed by a corresponding increase of the calculated Cronbach alpha (Cronbach, 1951) values in ten out of the twelve digital-literacy areas after all no-response data were removed. It must be noted that no-response refers to the participants deliberately selecting the 'No response' option that was included in each question of the questionnaire and does not reflect a generic refusal to answer specific questions by leaving them blank. Leaving certain questions unanswered was not allowed and this was technically enforced by making every question compulsory. Specifically, fifteen individuals were removed from the dataset as the 'No response' option was impossible to interpolate without making some fairly expansive assumptions. Removal of the participants who selected 'No response' reduced the sample size by (15%) resulting in a remaining sample size of $(n = 87)$ individual responses, but this was deemed to be acceptable as it significantly strengthened the robustness of the analysis when evaluating the performance of the questionnaire tool. For a complete documentation of the 'No response' data see Appendix - DigComp$_{v0}$ Floor/Ceiling No Response. The results of the 'No response' analysis have been summarised for each digital-literacy area (vertically) and for each participant (horizontally) in Table 11. The mean mode and median values have been calculated across the totals of the digital-literacy areas and for each participant separately. As areas of interest were identified those with a 'No response' total higher than the median value across the totals for each digital-literacy area $(\text{median} = 1.5)$ and across the individual responses $(\text{median} = 2)$. Seven participants demonstrated a dissimilar performance to that of their peers, indicated by their total number of 'No responses' across the digital-literacy areas, as their total number was higher than the median value. The exact reasons for this behaviour are unclear and cannot be deduced from the collected data. But if one had to speculate, the participants were potentially either very engaged with or disengaged from the process, resulting in certain answers to be omitted. If they were disengaged from the process, they might have mechanically selected the no response option. Vice versa, if they were really engaged, they might have decided not to provide an answer on purpose for some other reason.

Participants	General knowledge and functional skills	Use in everyday life	Specialised and advanced competence for work and creative expression	Technology mediated communication and collaboration	Information processing and management	Privacy and security	Legal and ethical aspects	Balanced attitude towards technology	Understanding and awareness of role of ICT in society	Learning about and with digital technologies	Informed decisions on appropriate digital technologies	Seamless use demonstrating self-efficacy	Total	Mean	Mode	Median
1	0	0	0	0	0	0	0	1	0	0	0	1	2	.17	0	0
2	0	0	0	0	1	0	0	0	0	0	0	0	1	.08	0	0
3	0	0	0	0	3	0	0	0	0	0	0	1	4	.33	0	0
4	0	0	0	0	2	0	0	1	0	0	0	0	3	.25	0	0
5	0	0	0	0	0	0	0	1	0	0	0	0	1	.08	0	0
6	0	0	0	0	0	0	1	0	0	0	0	0	1	.08	0	0
7	0	0	0	0	0	0	0	1	1	0	0	2	4	.33	0	0
8	0	0	1	1	0	0	0	4	0	0	0	0	6	.50	0	0
9	1	0	1	0	0	0	0	0	0	0	0	0	2	.17	0	0
10	0	0	1	0	0	0	0	0	0	0	0	0	1	.08	0	0
11	0	0	1	1	0	0	0	2	0	0	0	0	4	.33	0	0

Participants	General knowledge and functional skills	Use in everyday life	Specialised and advanced competence for work and creative expression	Technology mediated communication and collaboration	Information processing and management	Privacy and security	Legal and ethical aspects	Balanced attitude towards technology	Understanding and awareness of role of ICT in society	Learning about and with digital technologies	Informed decisions on appropriate digital technologies	Seamless use demonstrating self-efficacy	Total	Mean	Mode	Median
12	0	0	0	0	0	0	0	0	0	0	0	1	1	.08	0	0
13	0	0	1	0	1	0	0	0	1	0	0	0	3	.25	0	0
14	0	0	0	0	0	0	0	1	0	0	0	0	1	.08	0	0
15	0	0	1	0	2	0	0	2	0	0	0	1	6	.50	0	0
Competence Area Analysis													**Participant Analysis**			
Total	1	0	6	2	9	0	1	13	2	0	0	6	Total	40	Mean	2.67
Mean	.07	0	.40	.13	.60	0	.07	.87	.13	0	0	.40	Mode	1	Median	2
Mode	0	0	0	0	0	0	0	0	0	0	0	0				
Median	0	0	0	0	0	0	0	1	0	0	0	0				
Total	**40**	**Mean**	**3.33**	**Mode**	**0**	**Median**	**1.5**									

Table 11 - Participants with No Response

On a closer inspection of the 'No response' data, the areas of 'Specialised and advanced competence for work and creative expression', 'Information processing and management', 'Balanced attitude towards technology', and 'Seamless use demonstrating self-efficacy' had a total number of no responses significantly higher than the median value across the totals of each digital-literacy area, with a total of 6, 9, 13 and 6 'No responses' respectively. This indicated that these areas and the corresponding questions could possibly have been ambiguous and difficult to interpret. Within the area of 'Specialised and advanced competence for work and creative expression' question '3.2 I have mastered specialised digital skills needed by his/her area of work' there were four 'No responses' and question '3.5 I am able to remix different existing content into something new,' received two. Question 3.2 had been inadequately phrased as '… his/her area of work' instead of '… my area of work' and the ambiguity introduced by the phraseology could have triggered the no responses. Question 3.5 used the term 'remix', the meaning of which was perhaps not clear enough to the respondents.

For the 'Information processing and management' digital-literacy area, questions 5.2 and 5.3 generated one 'No response' each but, as single occurrences, they did not constitute a pattern and they did not merit any further analysis. However, question '5.4 I can integrate, compare and put together different types of information related to multimodal content' and '5.5 I am able to structure, classify, and organise digital information/content according to a certain classification scheme or genre' generated four and three 'No responses' respectively. In question 5.4 the word 'multimodal' might have been confusing for some of the participants and in question 5.5 the concept of classifying information according to different hierarchies or taxonomies may have been confusing for students who did not have prior experiences of this type of data/information synthesis and analysis. Examining the 'Balanced attitude towards technology' digital-literacy area shows that questions 8.2 and 8.4 only had one 'No response' each, and for this reason they have not been further investigated. Question 8.3 'I am able to assess and reduce/avoid technology-related threats to my health' had four 'No responses'. These respondents may have been unable to identify what those potential risks were, or they might not have been willing to acknowledge their lack of knowledge on the subject. This last interpretation is more probable as these individuals were all trainee healthcare professionals and they might have felt that it was not appropriate to be unable to recognise the potential health risks of technology. Question '8.5 I see digital media as enablers rather than inhibitors of choice and action' was the question with seven no responses, the highest number across all competency areas. The phrasing of this question cannot be considered as ambiguous as it does not include a term difficult to interpret, but it does require the individual to evaluate their views of technology and take a position as it is required by the question. Possibly these individuals felt that they were not prepared to do this within the context of the questionnaire, therefore, they decided not to respond. Finally, within the area 'Seamless use demonstrating self-efficacy' there were three questions that individuals decided not to respond. Questions 12.4 and 12.5 had only one 'no response' each and for this reason they were omitted from any further analysis. Question '12.3 I can access technology and use it without realising that I am actually using it' had four 'no responses'. This may have been because, to some extent, the question is difficult to interpret and includes a perceived logical conflict. Perhaps it should have been more appropriately phrased as 'I can access technology and use it without consciously realising that I am actually using it'.

4.2.2.4 Normality

Prior to commencing the exploratory analysis of the questionnaire instrument it was considered pertinent to examine the distribution characteristics of the data arising from the questionnaire tool. In particular, it was decided to examine the data in relation to normality and explore if the questionnaire tool produced data that were normally distributed. This was an important characteristic which, although it was not a requirement for the conducted exploratory analysis, it would give an indication on what types of further analysis could be applied posthumously. Normality or otherwise would dictate the types of statistical analysis that could be carried out.

An initial analysis of the results, based on the descriptive statistics presented in Table 12, showed that the digital-literacy area data, arising from the questionnaire, did not indicate normality. The skewness values showed that all digital-literacy areas were negatively (left) skewed with the exception of 'DLA6 - Privacy and security' which was positively (right) skewed. When examining the kurtosis, all digital literacy areas were platy-kurtic, with the exception of digital-literacy areas 'DLA5 - Information processing and management' and 'DLA11 - Informed decisions on appropriate digital technologies' which were leptokurtic. These results were also verified visually by examining the symmetry of the box plots presented in Figure 17.

	DLA1	DLA2	DLA3	DLA4	DLA5	DLA6	DLA7	DLA8	DLA9	DLA10	DLA11	DLA12
Mean	.788	.895	.726	.833	.705	.128	.825	.859	.811	.839	.818	.780
Standard Error	.018	.011	.020	.015	.018	.014	.015	.013	.016	.016	.016	.017
Median	0.76	0.92	0.76	0.8	0.72	0.08	0.84	0.88	0.8	0.8	0.8	0.8
Mode	1	1	0.92	1	0.8	0	1	1	1	1	0.8	0.8
Standard Deviation	.164	.102	.183	.140	.172	.128	.144	.124	.148	.147	.146	.156
Sample Variance	.027	.01	.034	.019	.03	.016	.021	.015	.022	.022	.021	.024
Kurtosis	-.341	-1.027	-.333	-.875	.638	-.302	-.270	-.838	-.837	-.508	.126	-.664
Skewness	-.473	-.498	-.554	-.335	-.561	.719	-.615	-.510	-.339	-.599	-.640	-.312
Range	.68	.36	.76	.48	.84	.48	.6	.4	.56	.56	.6	.56
Maximum	1	1	1	1	1	0.48	1	1	1	1	1	1
Minimum	.320	0.64	0.24	0.52	0.16	0	0.4	0.6	0.44	0.44	0.4	0.44
IQR	.240	.200	.260	.260	.200	.200	.220	.160	.220	.240	.160	.220

Table 12 - Questionnaire Analysis Digital Literacy Areas DigComp$_{v0}$ Descriptive Statistics

The descriptive statistics used to initially evaluate if the DigComp$_{v0}$ questionnaire data were normally distributed for each digital-literacy area.

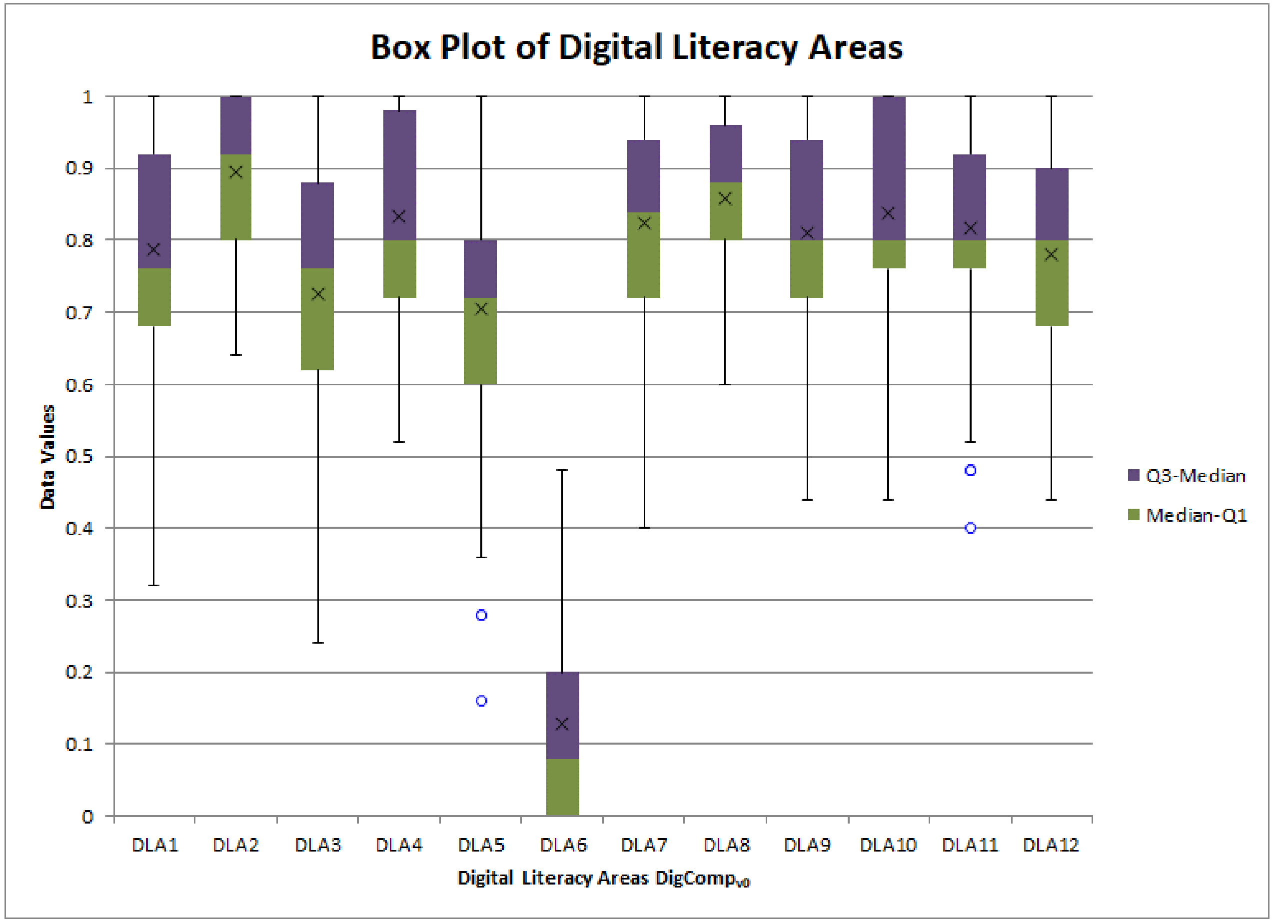


Figure 17 - Box Plots for the Digital Literacy Areas DigComp$_{v0}$

The Box plots illustrate the minimum/maximum value, the inter-quartile range (IQR) and the error bars for each DigComp$_{v0}$ digital-literacy area. The outliers, where they exist, are depicted as circles.

In an attempt to test if the data that resulted from the participants' responses to the questionnaire tool were normally distributed the Shapiro-Wilk's (1965) test was used. This systematic approach is considered as one of the most reliable tests of normality (Peat and Barton, 2005; Ghasemi and Zahediasl, 2012). The extended test (Zaiontz, 2013b) evaluates the W statistic that investigates whether a random sample $x_1, x_2 \dots x_n$ originates from a normal distribution with:

$$W = \frac{\left(\sum_{i=1}^{n} a_1 x_{(i)}\right)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{1}$$

Where $x_{(i)}$ are the ordered sample values and a_1 are constant co-efficients arising from the order statistics of a sample of size n from a normal distribution. It can be shown that for values of n between 12 and 5,000 the statistic $\ln(1 - W)$ is approximately normally distributed with mean:

$$\mu = 0.0038915(\ln n)^3 - 0.083751(\ln n)^2 - 0.31082 \ln n - 1.5861$$

and standard deviations of:

$$\sigma = e^{0.0030302(\ln n)^2 - 0.082676 \ln n - 0.4803}$$

Therefore, we can test the statistic by:

$$z = \frac{\ln(1 - w) - \mu}{\sigma} \tag{2}$$

Assuming that the null hypothesis H_0 requires that the sample comes from a normal distribution, and the alternative hypothesis H_a that the sample does not belong to a normal distribution, the null hypothesis is rejected if the p-value is less than the significance level $a = 0.05$. In practice this meant that there was a 5% chance that the null hypothesis might have been rejected incorrectly (type I error), but this was deemed to be acceptable. The results of the test have been summarised in Table 13 and show that the data did not conform to a normal distribution.

	DLA1	DLA2	DLA3	DLA4	DLA5	DLA6	DLA7	DLA8	DLA9	DLA10	DLA11	DLA12
W	.9409871	.8703169	.9561972	.9123397	.9666297	.8701284	.9296443	.8997297	.9334941	.8953862	.9164546	.9445373
p-value	.0006157	.0000003	.0050068	.0000204	.0240484	.0000003	.0001481	.0000055	.0002373	.0000035	.0000321	.0009843
α	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
H_0	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject

Table 13 - Questionnaire Analysis DigComp$_{v0}$ Shapiro-Wilk's Test for Normality

The Shapiro-Wilk's test for normality applied to the data arising from the questionnaire tool that was based on the DigComp$_{v0}$ classifications. The results of the test were statistically significant at ($\alpha = 0.05$) and it is concluded that there is sufficient evidence to reject H_0.

4.2.2.6 Factor Analysis

A factor analysis of the response data was conducted to confirm whether the digital-literacy areas were measuring one major underlying concept that would provide the theoretical grounding for utilising Cronbach's alpha (Cronbach, 1951) as a measure of internal consistency. Factor Analysis (FA), is a widely adopted multi-variate statistical analysis method (Velicer and Fava, 1998; Fabrigar, Wegener, MacCallum and Strahan, 1999; Child, 2006; Osborne and Costello, 2009; Yong and Pearce, 2013). The factors were extracted by utilisation of the Principal Axis (PA) method of factor analysis, as this method has proved to be usable for datasets that '*severely violate*' normality (Fabrigar et al., 1999, p.277). The purpose of utilising FA with PA extraction was to construct new components (factors) that were combinations of the $\text{DigComp}_{\text{V0}}$ digital-literacy areas (variables) maximising the shared portion of variance. The prerequisites of conducting FA were investigated by verifying the independence of the samples using the Kaiser-Meyer-Olkin Measure of Sampling Accuracy (KMO-MSA) criterion (Kaiser and Rice, 1974). Multi-collinearity was checked by examining the determinant of the correlation matrix. The homogeneity of variances was examined by employing the Brown and Forsythe's (1974) version of Levene's (1960) test, based on the median rather than the mean value, as this has shown that it is less susceptible to departure from normality. The linear relationship of all pairs of variables was checked visually, inspecting the scatter plot diagrams, and tested by using Spearman's ρ rank correlation coefficient (Cattell, 2012).

The KMO-MSA values range from 0 to 1. Where a value less than 0.5 indicates that the data variance does not support any further analysis, and where values above 0.5 indicate that the data is amicable to further analysis. Kaiser (1974) empirically defined a more nuanced scale where values between 0 to 0.49 were considered to be 'unacceptable', 0.50 to 0.59 'miserable', 0.60 to 0.69 'mediocre', 0.70 to 0.79) 'middling', 0.80 to 0.89 'meritorious' and 0.90 to 1 'marvellous'. Examining the results, summarised in Table 14, we find that the KMO-MSA values for all digital-literacy areas, with the exception of the area of 'General knowledge and functional skills' with a value of (0.74) that is considered as middling, can be characterised as meritorious or marvellous according to Kaiser's classifications. All digital literacy areas exhibit values significantly higher than the cut-off values of 0.5 and the overall KMO-MSA value is (0.87).

Digital Literacy Areas $DigComp_{v0}$	KMO-MSA
General knowledge and functional skills	.741
Use in everyday life	.803
Specialised and advanced competence for work and creative expression	.917
Technology mediated communication and collaboration	.801
Information processing and management	.907
Privacy and security	.892
Legal and ethical aspects	.873
Balanced attitude towards technology	.910
Understanding and awareness of role of ICT in society	.917
Learning about and with digital technologies	.902
Informed decisions on appropriate digital technologies	.882
Seamless use demonstrating self-efficacy	.907
Overall KMO-MSA	**.873**

Table 14 - The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) Questionnaire Data $DigComp_{v0}$

The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) values for the $DigComp_{v0}$ digital-literacy areas. The KMO criterion was used to verify the independence of the samples (Kaiser and Rice, 1974). The analysis shows that all areas exhibit values significantly higher than the cut-off values of 0.5 and the overall KMO-MSA value is (0.87). Based on these findings it was determined that the data sample was sufficient to be further analysed by conducting factor analysis.

Multi-collinearity has been examined by looking to establish if the determinant ($\det R$) of the correlation matrix (R) is $\det R \neq 0$ signifying that the matrix is not singular. The determinant ($\det R$) of the correlation matrix (R) is $\det R = 0.00002,$ which is $> 0.00001.$ Therefore, as $\det R \neq 0$, the correlation matrix is invertible. The homogeneity of variance was examined by employing Brown and Forsythe's (1974) version of Levene's (1960) test with $H_0 = \sigma_1^2 = \sigma_2^2 = \cdots = \sigma_k^2 \; and \; H_a = \sigma_i^2 \neq \sigma_j^2$. The value of the test statistic is $F = 1.7755$ at $a = 0.05, p = 0.0609$. Since, the $p > a$ the null hypothesis cannot be rejected and it is concluded that there is insufficient evidence to claim that the variances are not equal. The linear relationship of all pairs of variables was checked visually inspecting the scatter-plot diagrams and tested using Spearman's ρ rank correlation coefficient (Cattell, 2012). The results are summarised in Appendix - Digital Literacy Areas Spearman Correlation Coefficient DigComp$_{v0}$. Finally, an examination of the correlation matrix illustrated in Table 15 revealed that the variables were moderately correlated with correlation values $\rho_{x,y}$ falling between the ranges of $0.90 > \rho_{x,y} > 0.30$ or $-0.90 < \rho_{x,y} < -0.30$. The investigation of the prerequisites for conducting factor analysis indicated that there was evidence to conclude that there was a sufficient theoretical basis for proceeding with factor analysis.

Digital Literacy Area DigComp$_{v0}$	1	2	3	4	5	6	7	8	9	10	11	12
CA1. General knowledge and functional skills	1											
CA2. Use in everyday life	.717	1										
CA3. Specialised and advanced competence for work and creative expression	.621	.609	1									
CA4. Technology mediated communication and collaboration	.407	.660	.661	1								
CA5. Information processing and management	.462	.468	.670	.638	1							
CA6. Privacy and security	-.463	-.550	-.460	-.517	-.517	1						
CA7. Legal and ethical aspects	.313	.431	.576	.426	.628	-.534	1					
CA8. Balanced attitude towards technology	.501	.664	.643	.605	.614	-.604	.671	1				
CA9. Understanding and awareness of role of ICT in society	.535	.541	.703	.585	.646	-.549	.634	.690	1			
CA10. Learning about and with digital technologies	.547	.709	.794	.705	.633	-.611	.569	.735	.661	1		
CA11. Informed decisions on appropriate digital technologies	.538	.608	.780	.616	.718	-.555	.665	.647	.797	.804	1	
CA12. Seamless use demonstrating self-efficacy	.524	.549	.769	.700	.662	-.417	.571	.604	.711	.732	.8	1

Table 15 - Correlation Matrix Questionnaire Data DigComp$_{v0}$

Factor analysis is a method that aims to obtain the smallest number of factors that explain the variability of the associated variables. In order to identify the factors that accounted for a significant percentage of the variance based on the correlations of the variables the Scree test (Cattell, 1966; Upton and Cook, 2008) was employed since the digital-literacy areas have been measured on equivalent scales. Examining the graph in Figure 18 it was observed that the first factor accounts for most (72.94%) of the total variance and the rest of the components account for significantly less, ranging from (0.03%) to (7.65%). Interpreting that the cut-off point of the Scree test is after the first factor, as indicated by the sharp drop, leads to the conclusion that there is only one underlying construct that is explained by the variables representing the DigComp_{v0} digital-literacy areas. This conclusion is consistent with the results presented in Table 16 asserting Kaiser's (1960) criterion requiring that only factors with values greater than 1 are retained, based on the proposition that in order for a factor to manifest, it should explain, as a minimum, the same variance as one of the original variables.

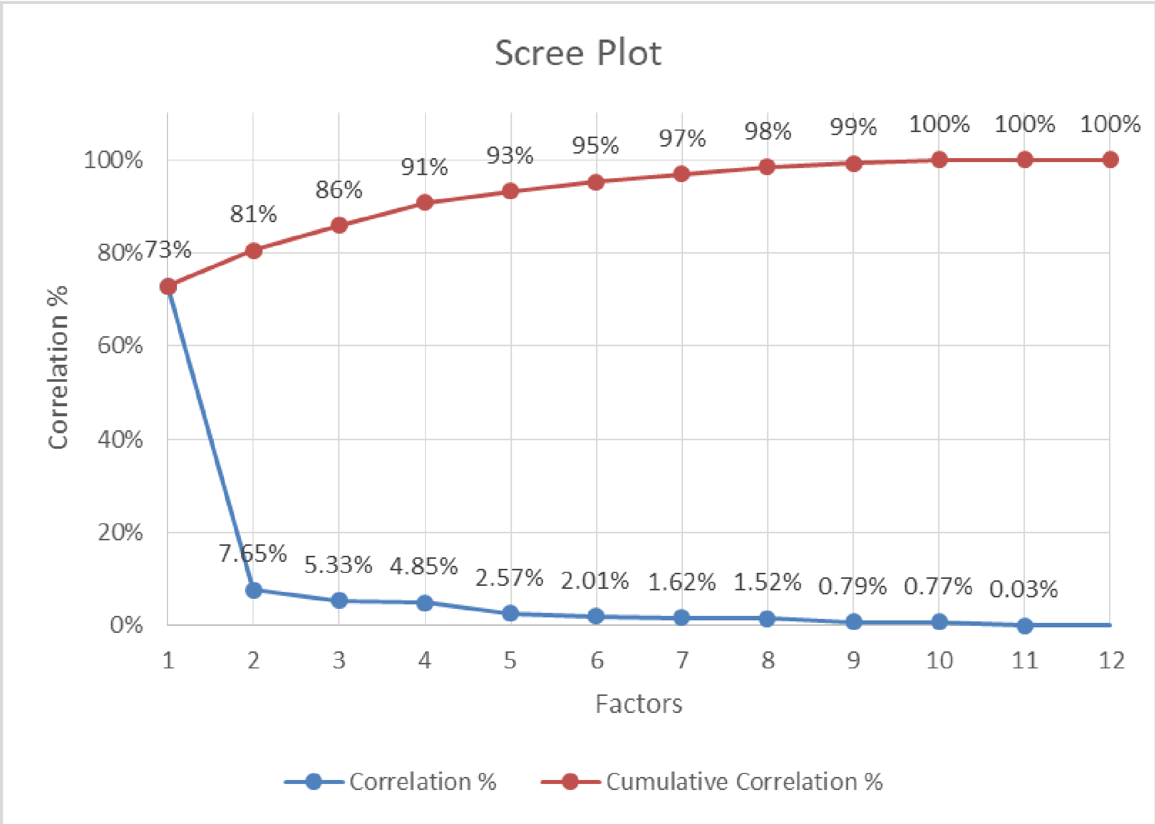


Figure 18 - Factor Analysis Correlation Scree Plot DigComp$_{v0}$

The correlation Scree plot for the factors arising from the questionnaire data DigComp$_{v0}$. The factors are illustrated on the x-axis where the correlation and cumulative correlation percentages on the y-axis.

Factors / Digital Literacy Areas (variables)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Eigen-values	***7.640***	***.801***	***.558***	***.508***	***.269***	***.210***	***.170***	***.159***	***.082***	***.081***	***.003***	***-.007***
General knowledge and functional skills	.245	-.596	.029	-.504	.309	-.062	.110	.139	.150	-.118	.065	-.397
Use in everyday life	.281	-.555	-.163	.165	-.140	.293	-.034	-.523	-.122	.123	-.214	.321
Specialised and advanced competence for work and creative expression	.312	.009	.326	-.166	-.146	.150	.326	.352	-.614	-.017	.182	.292
Technology mediated communication and collaboration	.284	-.059	.278	.711	.348	.004	-.079	.004	-.178	-.066	.108	-.398
Information processing and management	.282	.242	.037	-.002	.462	-.138	.477	-.064	.268	.462	-.237	.233
Privacy and security	-.243	.054	.507	-.143	-.134	.574	.028	-.114	.086	.385	-.155	-.346
Legal and ethical aspects	.259	.420	-.412	-.142	.019	.356	.265	-.255	-.165	-.363	-.138	-.355
Balanced attitude towards technology	.295	.029	-.379	.106	-.100	.413	-.159	.371	.309	.323	.462	.016
Understanding and awareness of role of ICT in society	.299	.171	-.024	-.219	.166	-.015	-.674	.200	-.229	.166	-.479	.006
Learning about and with digital technologies	.322	-.052	.045	.174	-.648	-.263	.193	.244	.239	.010	-.399	-.243
Informed decisions on appropriate digital technologies	.324	.201	.153	-.230	-.229	-.368	-.171	-.507	-.061	.262	.450	-.172
Seamless use demonstrating self-efficacy	.302	.146	.438	-.058	.018	.192	-.170	-.085	.489	-.521	.039	.327

Table 16 - Eigen-values and Eigen-vectors Questionnaire Data DigComp$_{v0}$

The reliability of both methods used to determine the significant components has been criticised in the literature as Cattell's (1966) visual Scree test is fairly subjective and Kaiser's (1960) criterion, in certain cases, has been shown to overestimate or underestimate the number of components (Zwick and Velicer, 1986; Ledesma and Valero-Mora, 2007). It has to be noted that there is not a mathematically analytical way to determine the amount of correlation that needs to be explained by the included components and, as such, the decision on how many components are considered as significant is down to subjective evaluation and methodological approaches to modelling.

Empirically, a factor can be considered as significant when it loads uniquely on several variables (Guadagnoli and Velicer, 1988; Pett, Lackey and Sullivan, 2003) with a loading of 0.5 or more without significantly <0.32 cross-loading on other variables (Osborne and Costello, 2009). Ideally the retained factors should load at 0.7, or more, indicating a statistically significant contribution accounting for nearly half of the variance attributable to the factor for that variable (Beavers et al., 2013). Additionally, robust and reliable factors should load significantly from three to five variables and make sense conceptually (Osborne and Costello, 2009).

Factors / Digital Literacy Areas (variables)	1	2	3	4	5	6	7	8	9	10	11	12	Com
General knowledge and functional skills	.678	**-.534**	.022	-.359	.160	-.029	.045	.055	.043	-.034	.004	-.034	.910
Use in everyday life	.777	-.497	-.121	.117	-.073	.134	-.014	-.209	-.035	.035	-.012	.028	.949
Specialised and advanced competence for work and creative expression	.862	.008	.243	-.118	-.076	.069	.134	.140	-.176	-.005	.010	.025	.897
Technology mediated communication and collaboration	.786	-.053	.208	**.506**	.180	.002	-.033	.002	-.051	-.019	.006	-.034	.958
Information processing and management	.779	.216	.028	-.002	.240	-.063	.197	-.025	.077	.132	-.013	.020	.779
Privacy and security	**-.672**	.049	.379	-.102	-.069	.263	.011	-.046	.025	.110	-.009	-.030	.697
Legal and ethical aspects	.715	.376	-.308	-.101	.010	.163	.109	-.102	-.047	-.103	-.008	-.031	.820
Balanced attitude towards technology	.816	.026	-.283	.075	-.052	.189	-.066	.148	.089	.092	.025	.001	.835
Understanding and awareness of role of ICT in society	.827	.153	-.018	-.156	.086	-.007	-.278	.080	-.066	.047	-.026	.001	.831
Learning about and with digital technologies	.891	-.046	.033	.124	-.336	-.121	.080	.097	.069	.003	-.022	-.021	.962
Informed decisions on appropriate digital technologies	.896	.180	.114	-.164	-.119	-.169	-.070	-.202	-.018	.075	.025	-.015	.970
Seamless use demonstrating self-efficacy	.836	.131	.327	-.041	.010	.088	-.070	-.034	.140	-.149	.002	.028	.881

Table 17 - Factor Analysis Full Load Matrix Questionnaire Data DigComp$_{v0}$

Inspecting the factor matrix summarised in Table 16, it can be observed that the first factor loads significantly to all variables indicating very strong correlations (> 0.7) for all variables with the exception of the 'General Knowledge' and 'Privacy and security' variable that load slightly less at (0.678) and (-0.672) repsectively. The absolute magnitudes are closely under the ideal theoretical threshold of 0.7 and well above the inclusion criterion value of 0.5. For this reason, they were considered as important, although not as important in respect to their contribution to the overall variance. The negative sign shows a correlation of the factor to this digital-literacy area in the opposite direction than that of the other variables. This was interpreted as a tendency for the association with the variable of 'Privacy and security' to decrease, as the other variables increase. However, it should be noted that this is an observed result arising from the characteristic behaviour of the group as it has been recorded by the participants' responses and it does not imply causality. Examining the rest of the factors and their loadings on the variables it was observed that factors 2 and 4 also appeared to load above the threshold value on the 'General knowledge and functional skills' and 'Technology mediated communication and collaboration' variables respectively. As these factor loadings were singular occurrences, they were not determined to be robust or stable enough to be included (Osborne and Costello, 2009).

Examining the validity of this approach there are some limitations as the sample size $(n = 87)$ was not large. Although it satisfies the criterion of having a minimum of five samples per variable, it is not sufficiently large to warrant high confidence, as factor analysis is deemed to be a '*large sample*' technique (Osborne and Costello, 2009, p.138). Nevertheless, the communalities of the variables are ranging from (0.7) to (0.97) and for this reason they can be considered as trustworthy as they are closer to the higher-end norm for social psychometric studies (Velicer and Fava, 1998). Moreover, the factor loadings ranging from (0.67) to (0.9) could be considered as significant. To some degree the high communality values and factor loadings counterbalance the need for a larger sample size.

The exploratory factor analysis has produced sufficient evidence to conclude that there is only one primary factor arising from the data set, as the factor loaded above the ideal value on all variables except one that was closely under the ideal loading value (0.7). This factor was postulated to be expressing digital literacy, as it was theorised by the expert consultation of the DigComp_{v0} framework preliminary study (Janssen et al., 2013). Having established that the data indicated that there was only one underlying concept, the internal consistency of the questionnaire was studied by utilising Cronbach's coefficient alpha (Cronbach, 1951).

4.2.2.7 Internal Consistency

In order to assess the reliability of the digital-literacy questionnaire tool the internal consistency of the scale was measured by calculating Cronbach's coefficient alpha (Cronbach, 1951). The reliability of a questionnaire instrument can be approximated from a single survey occurrence based on the associations of the question items (Goforth, 2015). Cronbach's coefficient alpha (α) was calculated by dividing the sum of variances of items by the scale variance, as indicated in equation (3) with k denoting the number of items in a scale, $\sigma_{y_i}^2$ the variance of item i and σ_x^2 the variance of the total scores observed.

$$\alpha = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum_{i=1}^{k} \sigma_{y_i}^2}{\sigma_x^2}\right) \tag{3}$$

The coefficient α ranges from 0 to 1 where a smaller number indicates a lesser degree of correlation and a larger number indicates a greater degree. At the extremes a value of 0 implies that the questions forming the scale are completely independent of each other, and a value of 1, as the number of question items approaches infinity, have a high covariance. A value of $a \geq 0.70$ has been considered as tolerable when examining the internal consistency of scales used in questionnaire instruments (Nunnally and Bernstein, 1994). In health studies, depending on the impact and potential risk of the interpretation of the results, even higher alpha values in the range between $0.70 \leq a \leq 0.95$ are expected in order to consider the results as consistent (Terwee et al., 2007b; a; Mokkink et al., 2010). A factor that needs to be taken into account when interpreting the alpha results is the number of questions used in a scale as the coefficient tends to increase for larger numbers (Gliem and Gliem, 2003). A very high value of alpha (e.g. $a > 0.95$) may also indicate potential redundancy within the scale and, as such, the question items may need to be reduced.

The overall Cronbach alpha for the complete digital literacy scale was ($a = 0.982$) [95% CI: 0.976, 0.987] and, as this scale was effectively constituted by sixty items with five questions forming the scale for each of the twelve digital-literacy areas, it was considered that this very high alpha value may have been due to the large number of items. For this reason, and for the purpose of strengthening the validity of the analysis, individual examination of the sub-scales was decided. It should also be noted that in the analysis that follows the ‘no responses’ have again been excluded as their inclusion would have distorted the results.

Cronbach’s alpha has been calculated for each of the twelve thematic areas of the DigComp_{v0} digital-literacy framework. Each area was constituted by five questions forming a scale that allowed each sub-concept to be examined individually. Overall, the results indicate that the self-assessment questionnaire is internally consistent, as the responses across all framework areas have alpha values falling within the acceptable range $0.70 \leq a \leq 0.95$. All digital literacy areas exhibit consistent responses with ($a \geq 0.8$). Half of the digital literacy areas were very consistent with an alpha of ($a \geq 0.9$). The overall alpha values, the index of measurement error and the confidence interval lower and upper bounds for the DigComp_{v0} digital-literacy areas are summarised in Table 18 (Kline, 1994; Tavakol and Dennick, 2011). The contribution of each question, towards the consistency of the responses within the scale has been investigated for each digital-literacy area by recalculating the a values after removing each question in succession, and denoted as $a_{(q-1)}$. The resulting $a_{(q-1)}$ value has been subtracted from the alpha values of each digital-literacy area denoted as a_{ca}. A positive value or difference between the two alpha values, denoted as a_{diff} indicates that the question contributes positively to the consistency of the responses, while a negative value indicates a negative impact of the same question on the consistency of the responses within the scale.

DL Area	1	2	3	4	5	6	7	8	9	10	11	12
'No responses' included												
a_{ca}	.819	.833	.835	.857	.874	.898	.869	.846	.828	.922	.897	.872
i_{me}	.329	.306	.303	.266	.236	.194	.244	.285	.314	.150	.196	.240
CI_{LB}	.757	.776	.778	.808	.831	.836	.824	.739	.769	.895	.862	.828
CI_{UB}	.869	.879	.881	.897	.909	.926	.905	.889	.876	.944	.926	.907
'No responses' excluded												
a_{ca}	.837	.849	.879	.902	.903	.893	.844	.875	.877	.927	.913	.919
i_{me}	.299	.280	.227	.187	.184	.202	.288	.234	.232	.141	.167	.155
CI_{LB}	.776	.792	.834	.865	.867	.853	.831	.828	.831	.900	.880	.889
CI_{UB}	.885	.894	.915	.931	.932	.925	.914	.912	.914	.949	.939	.943

Table 18 - Cronbach's Alpha Digital Literacy Areas DigComp$_{v0}$

The Cronbach's Alpha for the digital-literacy areas of DigComp$_{v0}$ including the confidence lower/upper bounds (confidence intervals) and the index of measurement error. The overall alpha values indicate a high internal consistency as they are all above the lower acceptable value of 0.70 with half of them being close to the upper boundary of 0.95 with values of over 0.9.

The ‘General knowledge and functional-skill scale had an overall alpha of ($a_{ca} = 0.837$). When question ‘1.2 I possess general computer skills (typing, using computers, getting into a new programme)’ was removed, there was an insignificant increase in the consistency of the scale in the order of (0.1%) when compared to the overall alpha value with ($a_{diff} = -0.001$) that did not warrant a revision of the scale. Removing question ‘1.1 I am able to use a digital device, which may be one of many types (e.g. Desktop PC, Laptop, Tablet, Smart phone)’ little increased the consistency of the responses with ($a_{diff} = 0.002$). However, the removal of questions 1.3, 1.4 and 1.5 had a more pronounced negative impact to the consistency. Question ‘1.4 I am familiar with the meaning of terms commonly used in user manuals for the operation of hardware and the installation and configuration of software’ in particular, contributed the most to the overall consistency of the responses within the scale with $a_{diff} = 0.086$.

Similarly, the consistency of the ‘Use in everyday life’ digital-literacy area scale, with an overall alpha of ($a_{ca} = 0.849$) was adversely affected by removing any of the questions, with the impact ranging from (1.2%) to (5.2%). Question ‘2.2 I am able to use at least office applications (or other work-related applications) to edit and create content (text, numeric, images)’ contributed the most to the overall response consistency with ($a_{diff} = 0.044$). On the other end of the spectrum question ‘2.3 I am able to search, collect, process, evaluate, share, store data and information using various devices, applications, cloud services’ contributed the least to the consistency with ($a_{diff} = 0.01$).

Removing questions 3.2, 3.3, 3.4 and 3.5 in the third digital-literacy area ‘Specialised and advanced competence for work and creative expression’, with an overall alpha of ($a_{ca} = 0.879$), resulted in degradation of the consistency of the responses within the scale ranging from (1.7%) to (5.5%). Question ‘3.5 I am able to remix different existing content into something new’ had the largest positive impact on the consistency of the responses in the scale with ($a_{diff} = 0.048$) whereas question ‘3.2 I have mastered specialised digital skills needed by his/her area of work’ also contributed positively with ($a_{diff} = 0.015$). However, question ‘3.1 I use technology to improve the quality of my work’ decreased the consistency of the responses within the scale with ($a_{diff} = -0.002$). As the impact amounted to (0.3%) the decrease in the response consistency was not considered substantial enough to merit a review of the scale.

Digital Literacy Scale Analysis (1-3)					
1. General knowledge and functional skills					
a_{ca}	.837 at [95% CI 0.776, 0.885]				
Question removed	*Q 1.1*	*Q 1.2*	*Q 1.3*	*Q 1.4*	*Q 1.5*
$a_{(q-1)}$	.835	.838	.797	.751	.77
$a_{diff} = a_{ca} - a_{(q-1)}$	.002	-.001	.04	.086	.068
i_{me}	.302	.298	.364	.436	.408
2. Use in everyday life					
a_{ca}	.849 at [95% CI 0.792, 0.894]				
Question removed	*Q 2.1*	*Q 2.2*	*Q 2.3*	*Q 2.4*	*Q 2.5*
$a_{(q-1)}$	.811	.804	.839	.826	.809
$a_{diff} = a_{ca} - a_{(q-1)}$	.038	.044	.01	.022	.039
i_{me}	.343	.353	.297	.317	.345
3. Specialised and advanced competence for work and creative expression					
a_{ca}	.879 at [95% CI 0.834, 0.915]				
Question removed	*Q 3.1*	*Q 3.2*	*Q 3.3*	*Q 3.4*	*Q 3.5*
$a_{(q-1)}$	.882	.864	.843	.837	.831
$a_{diff} = a_{ca} - a_{(q-1)}$	-.002	.015	.036	.042	.048
i_{me}	.223	.254	.29	.299	.31

Table 19 - Digital Literacy Areas DigComp$_{v0}$ Scale Analysis (1-3)

The Cronbach Alpha values and the impact of each question on the sub-scale for the Digital-Literacy Areas (1-3). The digital-literacy areas indicate high consistency with alpha values above 0.8. Questions 1.2 ‘I possess general computer skills (typing, using computers, getting into a new programme)’ and ‘3.1 I use technology to improve the quality of my work’ decreased the overall alpha values slightly by -0.001 and -0.002 respectively.

The ‘Technology mediated communication and collaboration’ digital-literacy area scale exhibited similar performance with an overall consistency of ($a_{ca} = 0.902$). When any of the questions were removed, the consistency of the responses on the scale was reduced to varying degrees ranging from (0.4%) to (4.8%). Question ‘4.1 I am able to communicate through ICT (e.g. email, instant messaging, video conferencing)’ contributed the least with ($a_{diff} = 0.004$), whereas question ‘4.4 I am able to take advantage of digital technology to cooperate and take part in networks and networked learning for personal or professional purposes’ contributed the most at with ($a_{diff} = 0.043$).

For the ‘Information processing and management’ digital-literacy area scale the consistency of the responses logged an overall alpha of ($a_{ca} = 0.903$). Removal of any of the questions within this digital-literacy area affected negatively the consistency, ranging from (0.1%) to (3.9%) of the overall alpha for this area. Question ‘5.3 I am able to gather relevant digital information, e.g. other users’ experiences, and to assess the quality of goods based on that information’ was the question that contributed the most to the consistency of the responses within the scale with ($a_{diff} = 0.035$). Similarly, question ‘5.1 I am able to judge the validity of content found on the Internet, how to find appropriate material, and what sources can be trusted’ increased the consistency of responses within the scale by a negligible amount with ($a_{diff} = 0.0005$).

The overall consistency of the responses within the ‘Privacy and security’ scale exhibited an alpha value of ($a_{ca} = 0.893$). Removing questions 6.1, 6.2, 6.3 and 6.4 reduced the consistency of the scale to varying degrees, ranging from (2.2%) to (4.9%). Question ‘6.4 I understand the risk of identity and other credential thefts and I am able to take steps to mitigate risk’ contributed the most to the consistency of responses within the scale with ($a_{diff} = 0.044$). Question ‘6.1 I understand the risks associated with online use and encounters with unknown persons’ contributed the least to the consistency with ($a_{diff} = 0.020$). However, question ‘6.5 I know that many interactive services use information about me to filter in commercial messages in more or less explicit manners’ reduced the consistency of the responses within the scale, but the importance was inconsequential at (0.3%) with ($a_{diff} = -0.002$).

Digital Literacy Areas Scale Analysis (4-6)					
4. Technology mediated communication and collaboration					
$\boldsymbol{a_{ca}}$	.902 at [95% CI 0.865, 0.931]				
Question removed	*Q 4.1*	*Q 4.2*	*Q 4.3*	*Q 4.4*	*Q 4.5*
$a_{(q-1)}$	.898	.879	.868	.859	.894
$a_{diff} = a_{ca} - a_{(q-1)}$	.004	.023	.034	.043	.008
i_{me}	.194	.227	.246	.263	.201
5. Information processing and management					
$\boldsymbol{a_{ca}}$	.903 at [95% CI 0.867, 0.932]				
Question removed	*Q 5.1*	*Q 5.2*	*Q 5.3*	*Q 5.4*	*Q 5.5*
$a_{(q-1)}$	.903	.890	.868	.870	.875
$a_{diff} = a_{ca} - a_{(q-1)}$	.0005	.013	.035	.033	.028
i_{me}	.185	.208	.247	.243	.235
6. Privacy and security					
$\boldsymbol{a_{ca}}$	.893 at [95% CI 0.853, 0.925]				
Question removed	*Q 6.1*	*Q 6.2*	*Q 6.3*	*Q 6.4*	*Q 6.5*
$a_{(q-1)}$	.874	.867	.864	.849	.895
$a_{diff} = a_{ca} - a_{(q-1)}$	.02	.026	.029	.044	-.002
i_{me}	.237	.249	.253	.279	.198

Table 20 - Digital Literacy Areas DigComp$_{v0}$ Scale Analysis (4-6)

The Cronbach Alpha values and impact of each question on the sub-scale for the Digital-Literacy Areas (4-6). The digital-literacy areas were highly consistent with alpha values close to or over 0.9. The question '6.5 I know that many interactive services use information about me to filter in commercial messages in more or less explicit manners' reduced the overall alpha by -0.002.

An overall alpha value of ($a_{ca} = 0.844$) was recorded for the 'Legal and ethical aspects' digital-literacy area scale, indicative of the consistency of the responses. All questions within the scale contributed positively to the overall consistency with their individual question contributions ranging from (0.3%) to (8.8%). Question '7.5 I have an advanced sense of suitable behaviour, finely tuned to media context, audience and legal provisions' contributed the most towards the consistency of the responses within the scale with ($a_{diff} = 0.074$), while question '7.4 I am aware of the different ways of licensing intellectual property production and I understand the differences between using copyright, public domain, copyleft and/or creative commons licenses' contributed the least at with ($a_{diff} = 0.002$).

The 'Balanced attitude towards technology' digital-literacy area scale revealed good overall consistency with an alpha value of ($a_{ca} = 0.875$) with the individual question impact ranging from (0.6%) to (4.4%). The largest contributor towards the consistency of the scale was question '8.1 I have a positive but realistic attitude towards the benefits and risks associated with information technologies' with $\left(a_{diff} = 0.039\right)$, whereas question '8.2 I understand that the digital environment we are facing can make things better or worse - it all depends on how we are using it and what rules we find for it' made the least significant contribution in the consistency of the results within the scale with ($a_{diff} = 0.005$).

The overall alpha value for the digital-literacy area of 'Understanding and awareness of the role of ICT in society' was measured as ($a_{ca} = 0.877$) indicating that the responses were satisfactorily consistent. Removing any of the questions that formed the measurement scale reduced the consistency of the responses, with the individual impact varying from (0.9%) to (4.3%). Question '9.1 I understand the role of ICT in everyday life, in social life and at work' contributed the least to the consistency of the scale with ($a_{diff} = 0.008$), while question '9.3 I am aware of the general trends within new media even if I do not use them' contributed the most with ($a_{diff} = 0.038$).

Digital Literacy Areas Scale Analysis (7-9)					
7. Legal and ethical aspects					
$\boldsymbol{a_{ca}}$	.844 at [95% CI 0.831, 0.914]				
Question removed	*Q 7.1*	*Q 7.2*	*Q 7.3*	*Q 7.4*	*Q 7.5*
$a_{(q-1)}$	.829	.819	.799	.842	.77
$a_{diff} = a_{ca} - a_{(q-1)}$	.015	.025	.045	.002	.074
i_{me}	.313	.329	.361	.291	.407
8. Balanced attitude towards technology					
$\boldsymbol{a_{ca}}$	.875 at [95% CI 0.828, 0.912]				
Question removed	*Q 8.1*	*Q 8.2*	*Q 8.3*	*Q 8.4*	*Q 8.5*
$a_{(q-1)}$	.837	.87	.846	.843	.845
$a_{diff} = a_{ca} - a_{(q-1)}$	.039	.005	.029	.032	.03
i_{me}	.3	.243	.285	.29	.286
9. Understanding and awareness of role of ICT in society					
$\boldsymbol{a_{ca}}$	.877 at [95% CI 0.831, 0.914]				
Question removed	*Q 9.1*	*Q 9.2*	*Q 9.3*	*Q 9.4*	*Q 9.5*
$a_{(q-1)}$	.868	.843	.839	.847	.851
$a_{diff} = a_{ca} - a_{(q-1)}$	.008	.034	.038	.029	.026
i_{me}	.246	.290	.296	.282	.276

Table 21 - Digital Literacy Areas DigComp$_{v0}$ Scale Analysis (7-9)

The Cronbach alpha values and impact of each question on the sub-scale for the digital-literacy areas (7-9). The digital-literacy areas are consistent with overall alpha values of over 0.8.

The 'Learning about and with digital technologies' digital-literacy area responses were consistent within the scale with an alpha value of ($a_{ca} = 0.927$). Removing questions 10.1, 10.2, 10.3 and 10.4 had a negative impact on the overall consistency, ranging from (1.7%) to (2.9%). Question '10.3 I can use ICT resources to safely expand my own knowledge and connect to the world around me' had the least significant impact with ($a_{diff} = 0.015$), while question '10.1 I am able to use digital media to learn (develop myself)' had the most significant impact on the consistency of the responses within this digital-literacy area with ($a_{diff} = 0.027$). Notably, removal of question '10.5 I am able to adapt smoothly to new technology and to integrate technology into my environment' increased the overall consistency of the responses within the scale with ($a_{diff} = -0.003$) but, as the increase was negligible, it was not considered as substantial enough to merit a revision of the scale.

Responses within the scale of the 'Informed decisions on appropriate digital technologies' digital-literacy area were likewise consistent with an overall alpha of ($a_{ca} = 0.913$). Removing any of the questions reduced the overall consistency of the responses within the scale, with the impact ranging from (0.8%) to (3.2%). Question '11.1 I understand the potential of digital devices and resources for my work' had the least significant impact on the consistency of the responses within the scale with ($a_{diff} = 0.007$), whilst question '11.4 I choose the most appropriate technologies according to the task' had the most significant impact on the scale for this digital-literacy area with ($a_{diff} = 0.029$).

Finally, the digital-literacy area 'Seamless use demonstrating self-efficacy' also got highly consistent responses within the scale, with an alpha of ($a_{ca} = 0.919$). Questions 12.1, 12.2, 12.4 and 12.5 contributed towards the consistency of the scale at degrees varying from (1.9%) to (3.4%). Specifically, question '12.2 I can use different ICT in a way that helps to achieve certain results more quickly, or more easily, or to achieve better results' was the highest contributor with ($a_{diff} = 0.031$) in contrast to the question '12.1 I am able to arrange and develop my personal working environment as an effective and reliable system' that had the least impact with ($a_{diff} = 0.017$). However, question '12.3 I can access technology and use it without realising that I am actually using it' had a negative impact on the consistency of the scale with ($a_{diff} = -0.009$). The negative impact on the overall consistency was (1%) and, as the overall consistency was rather high, it was not considered as significant enough to necessitate a revision.

Digital Literacy Areas Scale Analysis (10-12)					
10. Learning about and with digital technologies					
$\boldsymbol{a_{ca}}$	.927 at [95% CI 0.9, 0.949]				
Question removed	Q 10.1	Q 10.2	Q 10.3	Q 10.4	Q 10.5
$a_{(q-1)}$	.9	.908	.911	.902	.93
$a_{diff} = a_{ca} - a_{(q-1)}$	.027	.018	.015	.024	-.003
i_{me}	.191	.175	.169	.186	.135
11. Informed decisions on appropriate digital technologies					
$\boldsymbol{a_{ca}}$	.913 at [95% CI 0.880, 0.939]				
Question removed	Q 11.1	Q 11.2	Q 11.3	Q 11.4	Q 11.5
$a_{(q-1)}$	.906	.892	.892	.884	.891
$a_{diff} = a_{ca} - a_{(q-1)}$	.007	.02	.021	.029	.022
i_{me}	.180	.204	.204	.219	.207
12. Seamless use demonstrating self-efficacy					
$\boldsymbol{a_{ca}}$	.919 at [95% CI 0.889, 0.943]				
Question removed	Q 12.1	Q 12.2	Q 12.3	Q 12.4	Q 12.5
$a_{(q-1)}$	.902	.888	.928	.893	.892
$a_{diff} = a_{ca} - a_{(q-1)}$	.017	.031	-.009	.026	.027
i_{me}	.187	.212	.138	.203	.204

Table 22 - Digital-Literacy Areas DigComp$_{v0}$ Scale Analysis (10-12)

The Cronbach Alpha values and impact of each question on the sub-scale for the Digital-Literacy Areas (10-12). The digital-literacy areas are highly consistent with overall alpha values over 0.9. Questions '10.5 I am able to adapt smoothly to new technology and to integrate technology into my environment' and '12.3 I can access technology and use it without realising that I am actually using it' reduced the overall consistency with alpha values of -0.003 and -0.009 respectively.

In conclusion, the scales used to assess the digital-literacy areas have shown that they produce consistent responses of various degrees as it can be extrapolated from the responses of the participants. They all presented alpha values, well within the commonly accepted ranges close to, or well above, the middle point ($a = 0.85$) of the acceptable range (Terwee et al., 2007b; a; Mokkink et al., 2010). When the no responses were removed, the overall alpha values for the areas of '6. Privacy and security' and '7. Legal and ethical aspects' were slightly reduced by ($a_{diff} = 0.005$) and ($a_{diff} = 0.025$) respectively, in contrast to the other digital-literacy areas that indicated an increase in the overall alpha values. After closer examination of the distributions of the datasets and the 'no response' analysis, this was attributed to the intrinsic characteristics of the data and not to the existence of 'no responses' in these areas.

Examination of the effects of each individual question on the respective scales revealed that most questions positively contributed towards the consistency of the responses and, in the limited cases they had a negative impact, the impact was not substantial enough to merit a revision of the scales. This was because, even when the inclusion of questions introduced volatility, the effect on the total consistency was not sufficient to bring them outside the acceptable range, nor did it affect the overall alpha values substantially enough so as to justify a review of the questions and deviation from the initial conceptualisations of the $\text{DigComp}_{\text{v0}}$ framework. This was particularly important within the context of this exploratory research project that evaluated the DigComp framework formulations for their applicability as a measurement tool to quantify digital literacy.

4.2.2.8 Test/Retest Reliability

The test/re-test reliability that measures how persistent the individual responses over time were was not analysed for two reasons. The necessary permissions were proven difficult to acquire as the teaching and management teams were reluctant to authorise the issuing of the same questionnaire to the same group of students, contemplating that this might have a negative impact upon the student experience. This issue was compounded by the fact that, at the time, this questionnaire was perceived to be part of a small doctoral-research project lacking a clear mandate from the wider institution. Most important, during the issuing of the questionnaire, the finalised version of the $\text{DigComp}_{\text{v1}}$ was published with some significant structural differences. For example, the twelve digital-literacy areas had been reduced to five with some areas subsumed into others and some others having been omitted altogether. Because of this development and limitations of the response format utilised within the scales to measure digital literacy objectively, the decision not to re-issue the initial questionnaire was taken. The creation of a new questionnaire utilising a different response format and based on the DigComp_{v1} framework taxonomy was decided instead.

4.2.3 Interpretation of the Results

Inspection of the response data reveals that ceiling effects are evident in all digital-literacy areas except for the area of ‘6. Privacy and security’ that exhibits floor effects (see: Appendix - DigComp_{v0} Floor/Ceiling No Response). The terms ‘ceiling’ and ‘floor’ describe the situation where a large number of the participants score near the top or the bottom of the measurement scale respectively (Salkind, 2010). The appearance of floor or ceiling effects is considered to be problematic as it reduces the resolution of the measurement and, consequently, the variance of the data (Hessling, Traxel and Schmidt, 2011). In this case the percentages of maximum responses within the competence-area scales that display ceiling effects range from (7%) to (70%), whilst the percentages of minimum responses for this digital-literacy area, the only area exhibiting floor effects, range from (35%) to (63%). One conceivable explanation for the floor and ceiling effects is arguably potential inadequacies in the definitions of the questions constituting the corresponding digital-literacy areas and the response format used.

An alternative explanation of the apparent positive bias in the responses is the possibility the pilot group to have been highly digital-literate indeed, an interpretation that is supported by evidence provided by the EU Digital Scoreboard (European Commission, 2016). A survey run in 2015 showed that 40% of the UK population had above basic digital skills, 27% basic, 24% low and 9% no digital skills at all (see: Figure 19). It is conceivable that the participants of intervention 2 belong to the segment of the wider population that has been found to possess above basic digital skills. This explanation is plausible, considering the demographics of the participants who could be characterised as reasonably sophisticated individuals with access to tertiary education. Therefore, they were likely to have increased opportunities and developed their digital skills through engagement with technologies during their preparatory studies.

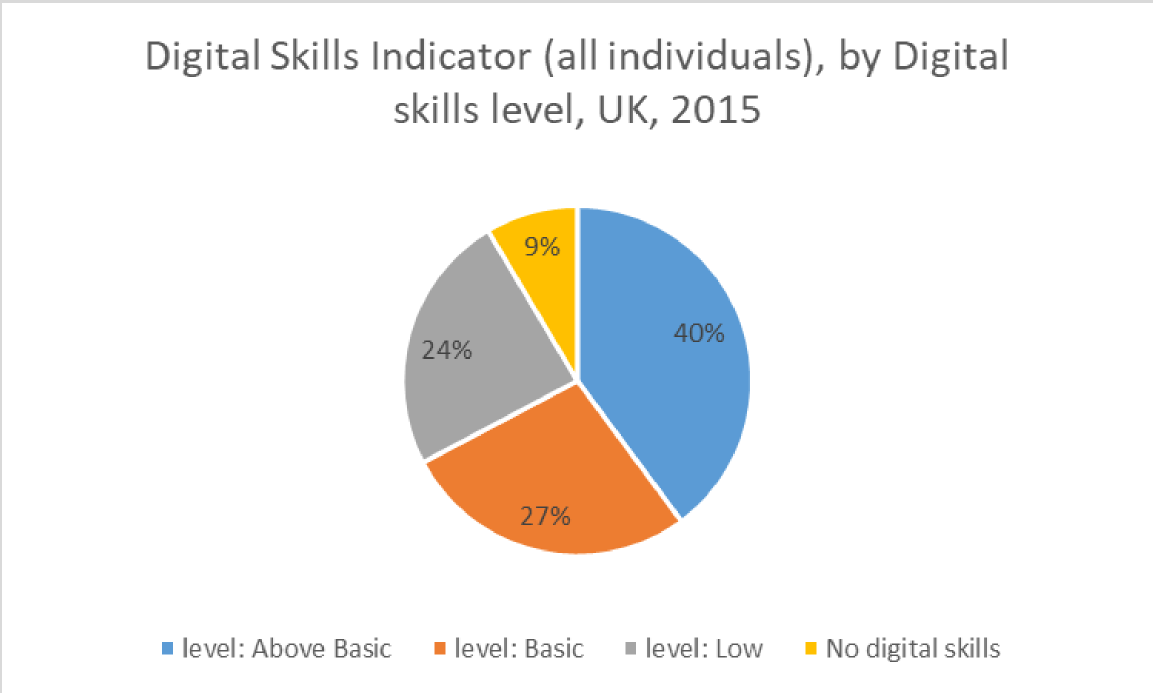


Figure 19 - EC Digital Agenda Scoreboard: Digital Skills Indicator

The European Commission's Digital Scoreboard from Eurostat data illustrating the digital skills indicator for the United Kingdom in 2015 (European Commission, 2016). 67% of the respondents showed basic or above basic digital skills while 33% had low or were completely lacking digital skills. These figures suggest that a large part of the population (40%) had above basic digital skills. Therefore, it is plausible that the apparent positive bias is not a direct result of the instrument but an intrinsic characteristic of the participants as, by analogy, they had a good chance to belong to the more capable segment of the population.

A noteworthy result was observed when the findings of the original EU DigComp$_{v0}$ Delphi study (Janssen and Stoyanov, 2012) were compared to the self-reported results of the questionnaire participants illustrated in Figure 20. The average (mean) values of the questionnaire that represent self-assessed capability, which was the result of this research, appear to track very closely those of the DigComp$_{v0}$ study that depict the relative importance of the validated competences with a notable exception. Specifically, the expert group was asked to prioritise the validated statements by using a four-step response format (most, some, few and none), and rate their perceived importance in relation to an individual that could be characterised as digitally literate. The participants' self-assessed competence in the area of '6. Privacy and security', as evidenced by all the underlying questions (6.1 to 6.5), was not coherent with the experts' perceptions of importance. Although the experts rated this area as important in order to characterise a person as digitally literate, the questionnaire respondents, on average, have not felt confident in their respective capabilities. It should also be noted that the question of '1.4 I am familiar with the meaning of terms commonly used in user manuals for the operation of hardware and the installation and configuration of software' was not rated in the original study; therefore, it could not be compared. The overall digital-literacy area results illustrating the mean values of each digital-literacy area are summarised in Figure 21. Examining the results at the digital-literacy area level, the overall similarities were apparent.

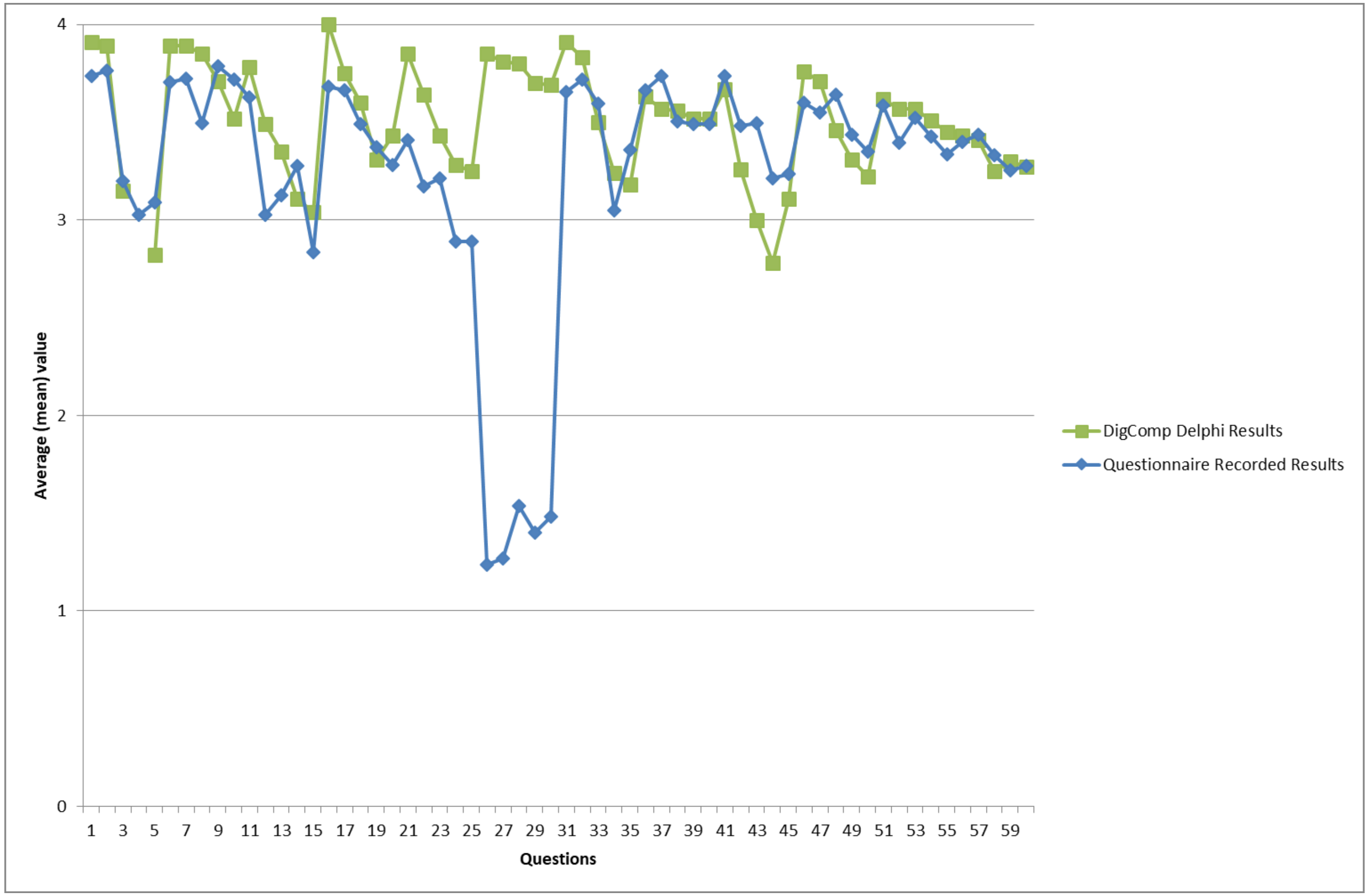


Figure 20 - Average (mean) Values of Expert Consultation Rating Importance and Observed Values of the Questionnaire Questions DigComp$_{v0}$

The average values from the expert consultation, rating the importance of each question, have been found to be surprisingly close to the observed values that were self-reported by the participant group when compared question by question with the exception of digital area 6 'Privacy and security'.

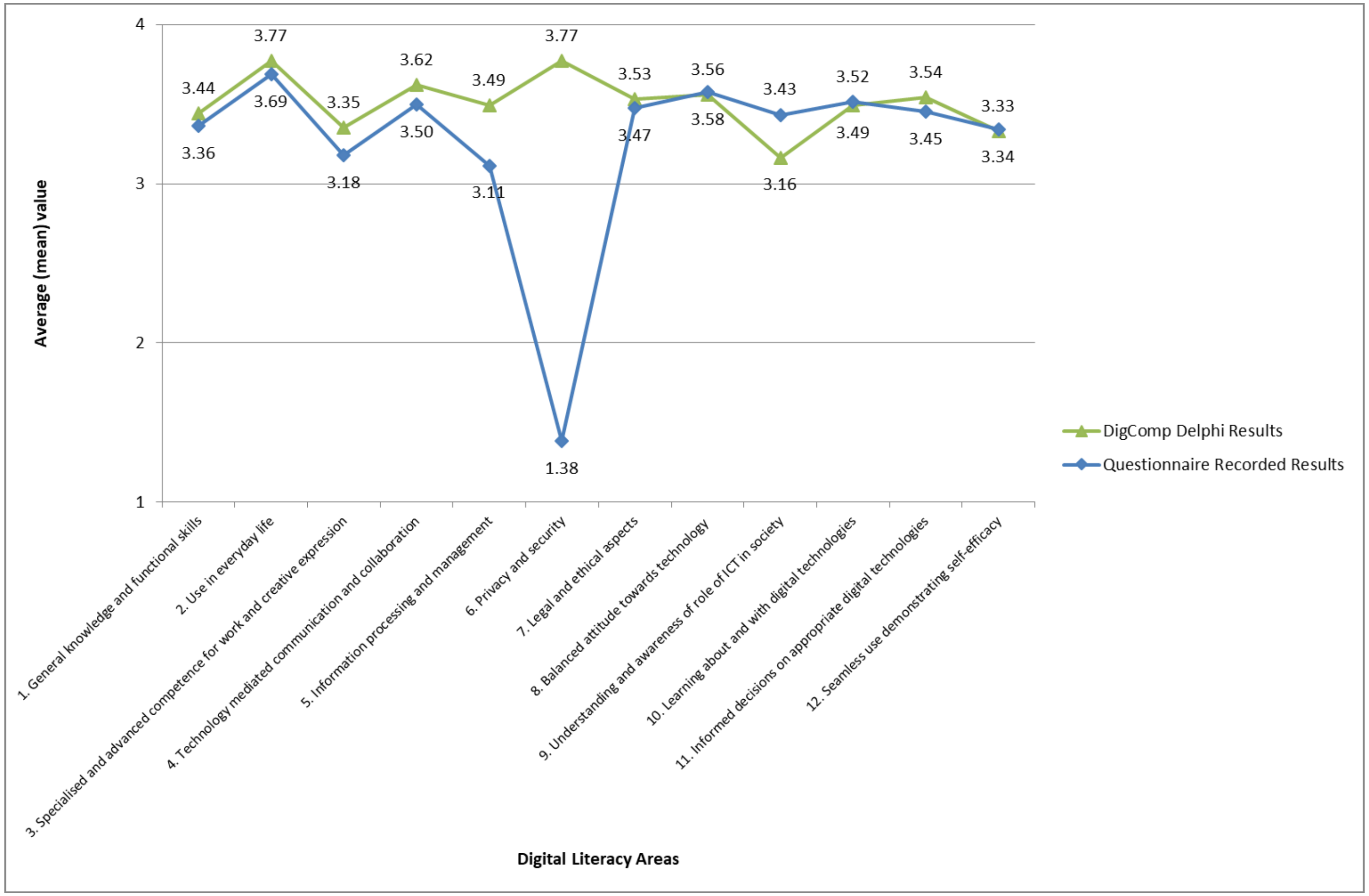


Figure 21 - Average (mean) Values of Expert Consultation Rating Importance and Observed Values of the Questionnaire Digital Literacy Areas DigComp$_{v0}$

The average values from the expert consultation, rating the importance of each question, have been found to be surprisingly close to the observed values that were self-reported by the participant group when comparing each digital-literacy area.

In an attempt to quantify the significance of the correlation, Spearman's ranked correlation technique (Spearman, 1904; McCrum-Gardner, 2008) was used to assess the hypothesis (H_0) that the results were not correlated, by comparing the ranks of the average mean values. As it can be observed in Table 23, the absolute value of rho ($\rho = 0.552$) is greater than the critical value of rho ($\rho_{crit} = 0.417$) at an alpha of ($\alpha = 0.001$).

Spearman's Ranked Correlation	
ρ	0.552
t_{stat}	5.042
p_{value}	0.000005
α	0.001
ρ_{crit}	0.417
is $\rho > \rho_{crit}$	Yes
is $p_{value} < \alpha$	Yes

Table 23 - Spearman's Ranked Correlation Results Questionnaire (DigComp$_{v0}$) vs Experts' Results

Since $\rho > \rho_{crit}$, it enables the rejection of the null hypothesis (H_0) that there is no correlation (Ramsey, 1989). As the $p_{value} < \alpha$ the correlation between the average (mean) values of the expert consultation ratings of importance and the self-reported values of the participants for the digital-literacy areas of the DigComp$_{v0}$ questionnaire is statistically significant. This result confirmed that the digital-literacy profile of the participant group followed the digital-literacy importance profile that arose from the EU DigComp$_{v0}$ expert consultation (Janssen and Stoyanov, 2012).

In conclusion, having investigated the validity and performance of the questionnaire it can be concluded that the instrument produces a reliable, although not always very sensitive, measure of digital literacy. The analysis of the consistency of the participants' responses showed that these were internally consistent. The internal consistency analysis showed that some of the questions were not optimally formulated, and this might have been the reason they triggered a number of 'no responses'. However, since these were removed from the dataset, they did not affect the subsequent analysis. The apparent floor and ceiling effects were partly attributed to the limited sensitivity of the questionnaire and the choice of the response format, although other reasons relating to intrinsic characteristics of the group have been explored. The factor analysis showed that the digital-literacy areas utilised in the questionnaire were measuring one underlying concept, postulated to be that of digital literacy. Some other latent concepts, identified in the data set, were not reliable enough to be further considered. An alternative interpretation of the reasons for the apparent ceiling effects, or high degrees of digital literacy recorded among the participants, explored the possibility that these could be partly attributed to the intrinsic traits of the sample group that was demonstrating an above the basic digital capability.

4.2.4 Application into Practice

Examination of the participants' responses, after the individuals with 'no responses' had been removed, revealed a snapshot of the digital-literacy potential of the group. This type of analysis was carried out to investigate the applicability of the questionnaire tool for the purpose of quantifying the digital-literacy potential of students and inform local practice. This inquiry is linked to the second research question and aims to explore how measures of digital literacy can be leveraged to inform the design of activities, and evaluate the student learning experiences. The data was analysed in an attempt to evaluate and map the digital-literacy characteristics of the participants as a group, with the results summarised in Figure 22. It was observed that the group exhibits a reasonably high level of digital literacy in all digital-literacy areas as measured by the group's mean values, ranging from (0.7) to (0.9) on a scale from 0 to 1, where a value of 0 indicates no skills, and 1 the highest level of competency, except for the areas of 'Privacy and security' where the self-reported performance of the group is comparatively low, with the mean value of just (0.13).

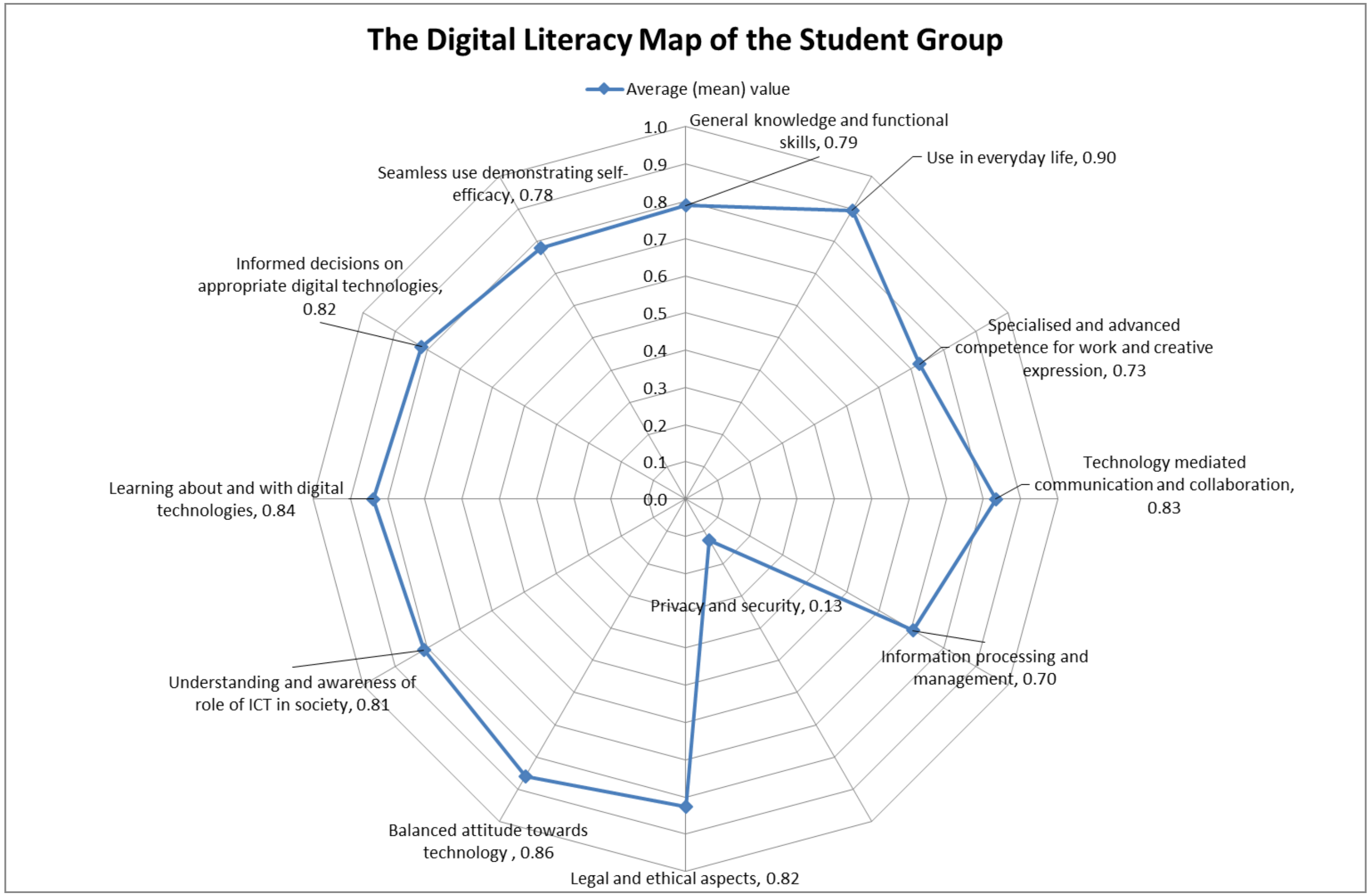


Figure 22 - Digital Literacy Characteristics of the Student Group DigComp$_{v0}$

The average (mean) values of the student group for each digital-literacy area DigComp$_{v0}$ are presented in the form of a radar graph. This graph illustrates the same information as Figure 21 above, in a format that makes it easier to identify areas of interest. The ‘Privacy and Security’ digital-literacy area is underdeveloped with an average index value of 0.13.

An alternative way to visualise the data in a more compound format was to aggregate the individual responses at a group level by summarising the responses on the agreement scale. Specifically, the aggregation of the results was carried out by counting the individual responses for each one of the six steps on the agreement/disagreement response format, and summarising them into a binary format categorised either as ‘Agree’ or ‘Disagree’. This type of visualisation more explicitly demonstrated that the participants reported reasonably high levels of agreement with the statements comprising the scales of the digital-literacy areas, with the exception of the ‘Privacy and security’ area. Agreement with the statements ranged from (83%) for the area of ‘Specialised and advanced competence for work and creative expression’ to (99%) for the area of ‘Use in everyday life’. However, a (97%) disagreement in the area of ‘Privacy and security’ indicated that the vast majority did not consider themselves competent in this area.

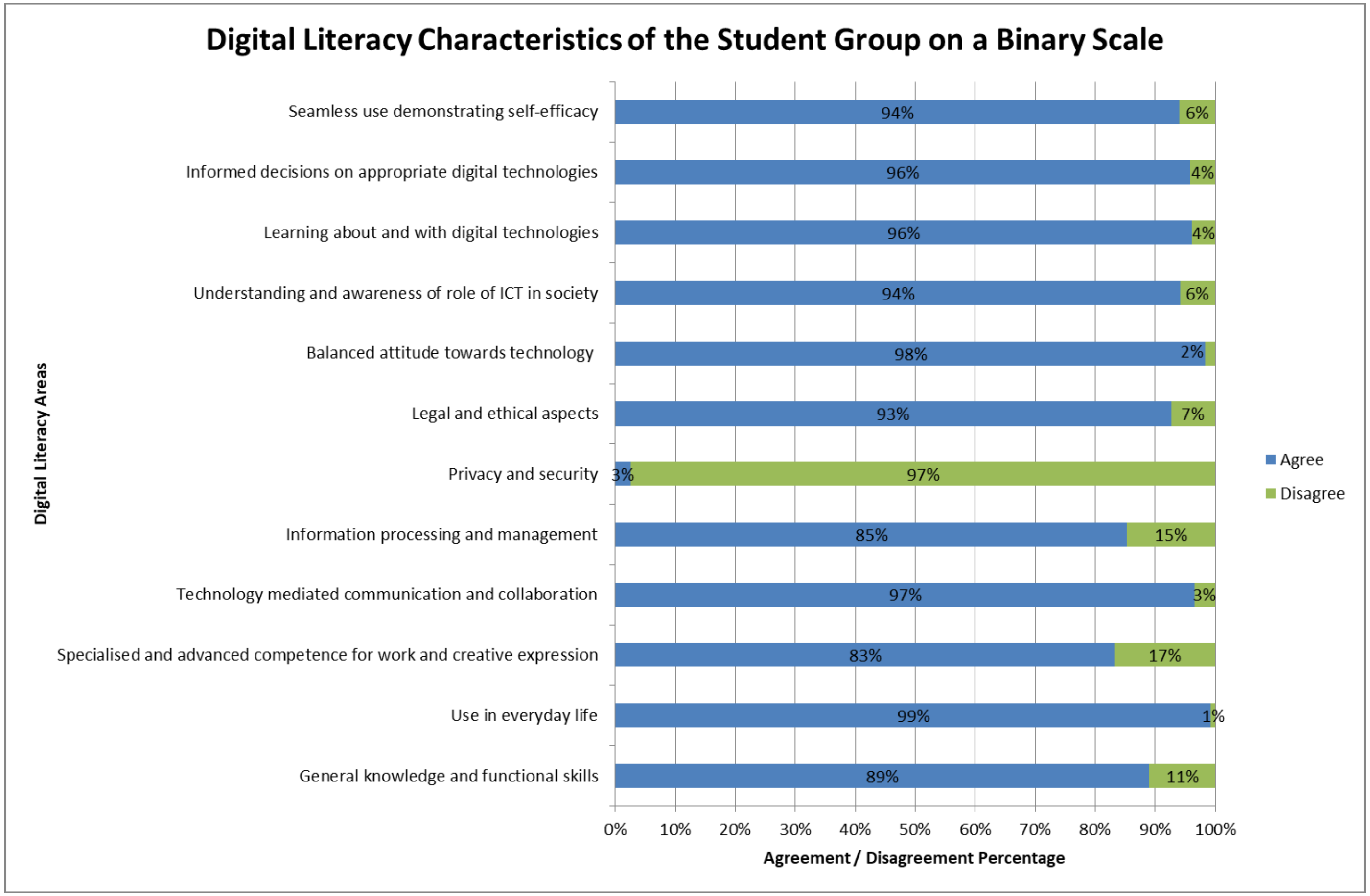


Figure 23 - Self-reported Characteristics of the Group DigComp$_{v0}$

The self-reported digital-literacy characteristics of the student group arising from the DigComp$_{v0}$ questionnaire tool illustrated on a binary scale providing a compound view of the results.

A more detailed analysis of the two extremes, the best and worst performing digital-literacy areas, has been carried out and summarised in Figure 24 and Figure 25. The group felt very confident in using technology in their everyday life with almost all respondents (98%) agreeing to all of the above statements that defined this digital-literacy area. It is interesting to note that a large portion of the participants, ranging from (38%) to (67%) according to the specific question, felt very confident about their skills, others (31%) to (43%) felt just confident, some (2%) to (17%) to some extent confident, and a very small percentage (1%) to (2%) not very confident. In contrast, examining the area of 'Privacy and security' a similar situation in the opposite direction was noted. The vast majority of the participants (93%) declared that they were not confident in any of the circumstances defining the 'Privacy and security' digital-literacy area. A large portion of the group (39%) to (63%) was not at all confident, a significant proportion (33%) to (44%) felt that they were not confident, some responded as not very confident (2%) to (16%), a small percentage (3%) to (5%) felt slightly confident, and only few (1%) to (2%) stated that they were confident.

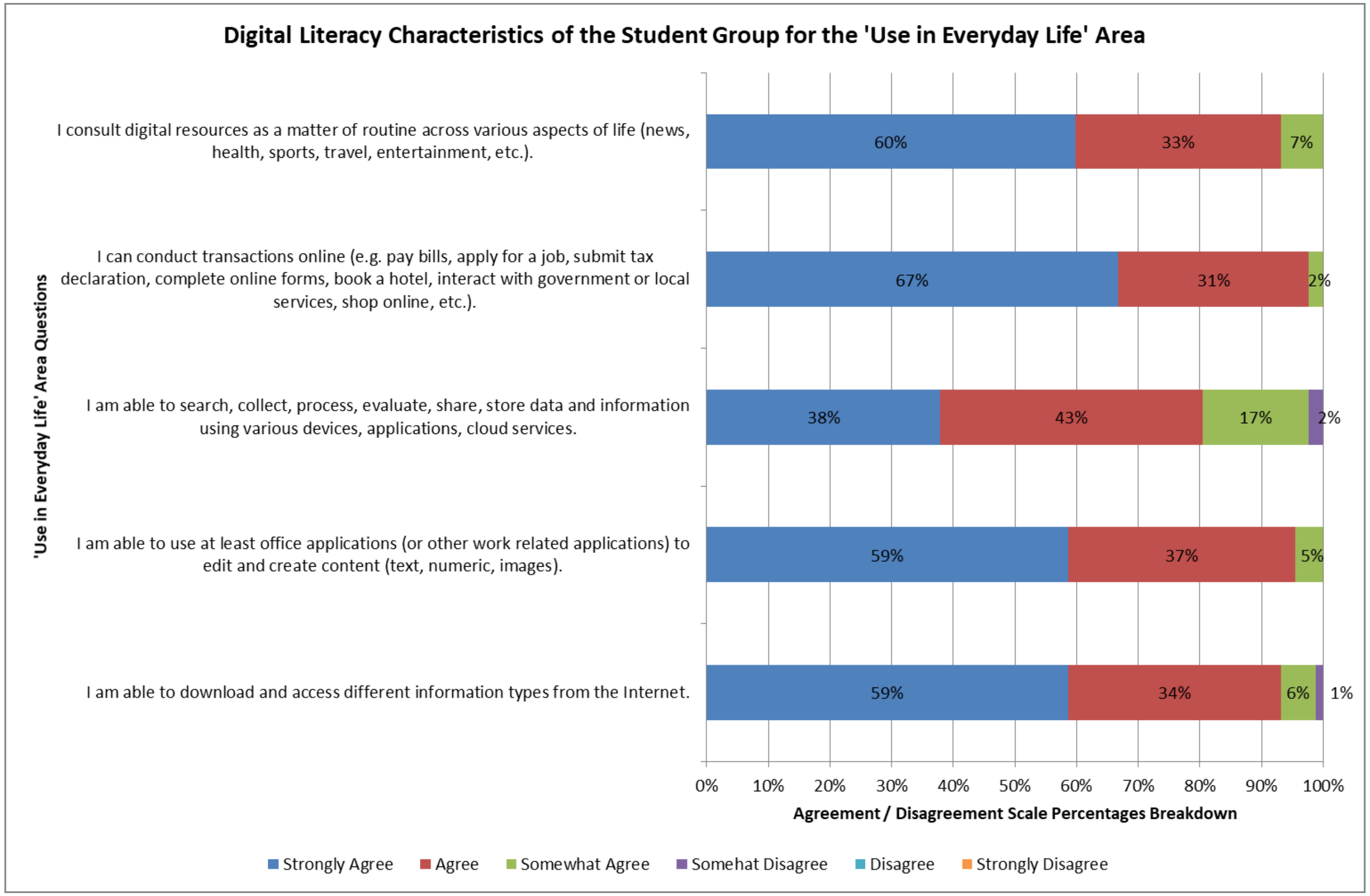


Figure 24 - Use in Everyday Life Digital Literacy Area Scale Breakdown Group Results DigComp$_{v0}$

The self-reported digital-literacy characteristics of the student group arising from the DigComp$_{v0}$ questionnaire tool illustrated on the full agreement/disagreement for the digital-literacy area of 'Use in Everyday Life'. It can be observed that although there are large numbers of participants that strongly agree there are others that do not feel as confident.

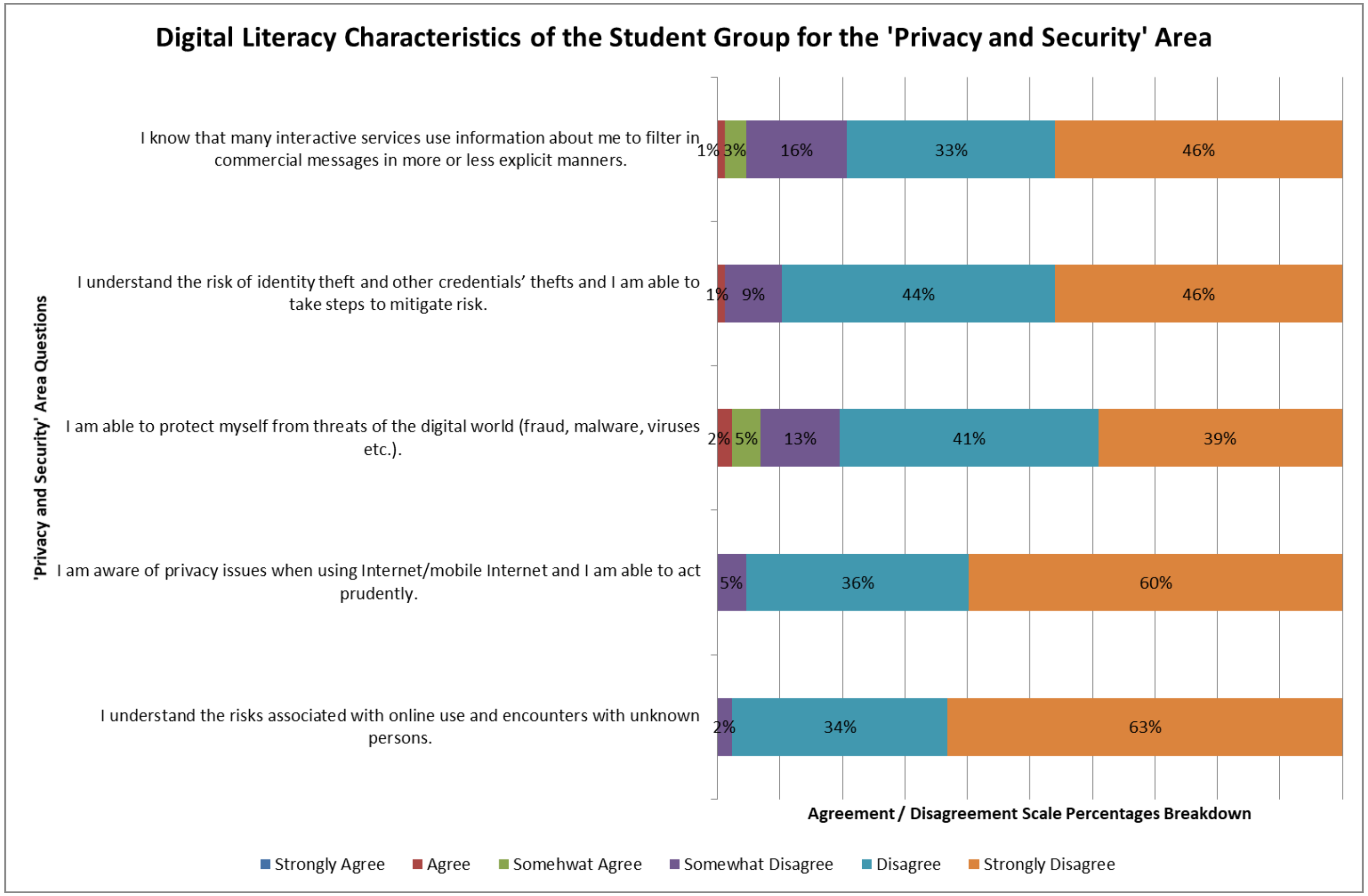


Figure 25 - Privacy and Security Digital Literacy Area Scale Breakdown Group Results DigComp$_{v0}$

The self-reported digital-literacy characteristics of the student group arising from the DigComp$_{v0}$ questionnaire tool illustrated on the full agreement/disagreement for the digital-literacy area of 'Privacy and Security'. In contrast to Figure 24 for this digital literacy area there are large numbers of participants that strongly disagree but others are more confident.

The results demonstrate the potentials and limitations of the tool in respect to its applicability in practice, and are not intended to give an exhaustive view on the digital-literacy characteristics of the group. For the purpose of this analysis the evaluation of the toolkit is focused on its applicability by recording a snapshot of the characteristics of the digital-literacy potential of the participants examined as a group. The group can be described to some extent as homogeneous, although the individuality of the participants should not be discounted. Their homogeneity arose from the fact that they were all under-graduate students. Therefore, they were all educated individuals but not in what could be described as a traditional technology-intensive discipline. Competence, or engagement with basic technologies, was not a prerequisite, but acknowledgement of the need to use some types of technology, and willingness to learn were implicitly assumed since the pilot group was in a higher educational setting. The existing intrinsic, positive bias in self-evaluations of this type, a fact also identified by experts in the field (Beetham, 2013c; ECDL Foundation, 2018), was acknowledged and was partly due to the users' over-confidence. The generic nature of the framework also encouraged positive bias as the survey questions focused more on generic attitudes and capabilities and less on specific skills, thus allowing for the assessment of a generic digital-competence level that was based on the participants' experiences, although not without certain drawbacks.

Measurements of this type are not precise, and as such, they may not be repeatable because of the subjective nature of the described attitudes and the fuzziness introduced by the response format used, which was based on an agreement scale. The participants were asked to self-evaluate by recording their agreement with generic statements that described attitudes towards technologies. This meant that the interpretation of the meaning of the statements was left to the discretion of the individual. Therefore, it heavily depended on the individual's experiences of technology. As a result, the interpretation of the meaning of a certain statement depended upon the participant's own experiences and understanding and for this reason, the results should not be contrasted or compared among individuals. However, they can be used as a rough guide to estimate the general digital-literacy competence level.

In conclusion, the toolkit offers quantitative insights into the student digital capabilities by inviting individuals to express their attitudes towards technology in a loosely prescribed way that encourages reflection of their own experiences and their self-evaluation against a set of criteria comprehensively describing digital literacy. This approach cannot be used to measure the existence of digital skills in fine-grained detail, nor should it be used as a comparison, or a grading tool. It can successfully be used to quantitatively evaluate the general level of digital competence of individuals and groups, and produce visual maps of digital literacy. At a group level the tool works satisfactorily as individual attitudes are brought together to give a holistic view of a group's digital-literacy characteristics. Such estimations are useful when identification and quantification of the digital capabilities are needed. For example, when designing curricula for the needs of the 21st-century health professionals.

4.2.5 The Online Learning Designs and the Student Experience

The learning designs were co-authored with the tutor team and documented graphically by using the CompendiumLD learning design software developed under the auspices of the Open University Learning Design Initiative (The Open University, 2011). A map of the learning designs generated to deliver selected digital literacies can be seen in Figure 26. Of overarching priority for the development of learning designs was the delivery of learning resources that were relevant to the disciplinary curriculum. The primary purpose of the technology-enabled learning activities from a learning perspective was to ensure that the students would be completing work in preparation of their taught sessions. An equally important but less pronounced secondary objective was to encourage the students to produce a variety of technologically-mediated artefacts, so as to demonstrate the existence or acquisition of digital capabilities.

A design workshop was facilitated by the author of this thesis where the tutors identified the disciplinary areas of focus and collaborated in constructing the technology-enhanced activities. The workshop followed a traditional curriculum-development format where the disciplinary learning outcomes were defined in relation to the curriculum objectives. Suitable types of technology-enhanced learning activities were formulated with the focus on how to best deliver the disciplinary objectives and the digital literacies identified in the DigComp$_{v0}$ framework. As these technology-enhanced learning activities were not part of the summative assessment, but were introduced as formative elements of the curriculum delivery, they had to be constrained so as to be easily accessible, reasonably simple and not too onerous for the students. Furthermore, the activities had to be designed in a way that was challenging enough but, at the same time, optimised, so as to enable the students to complete them without requiring substantial academic or technological support.

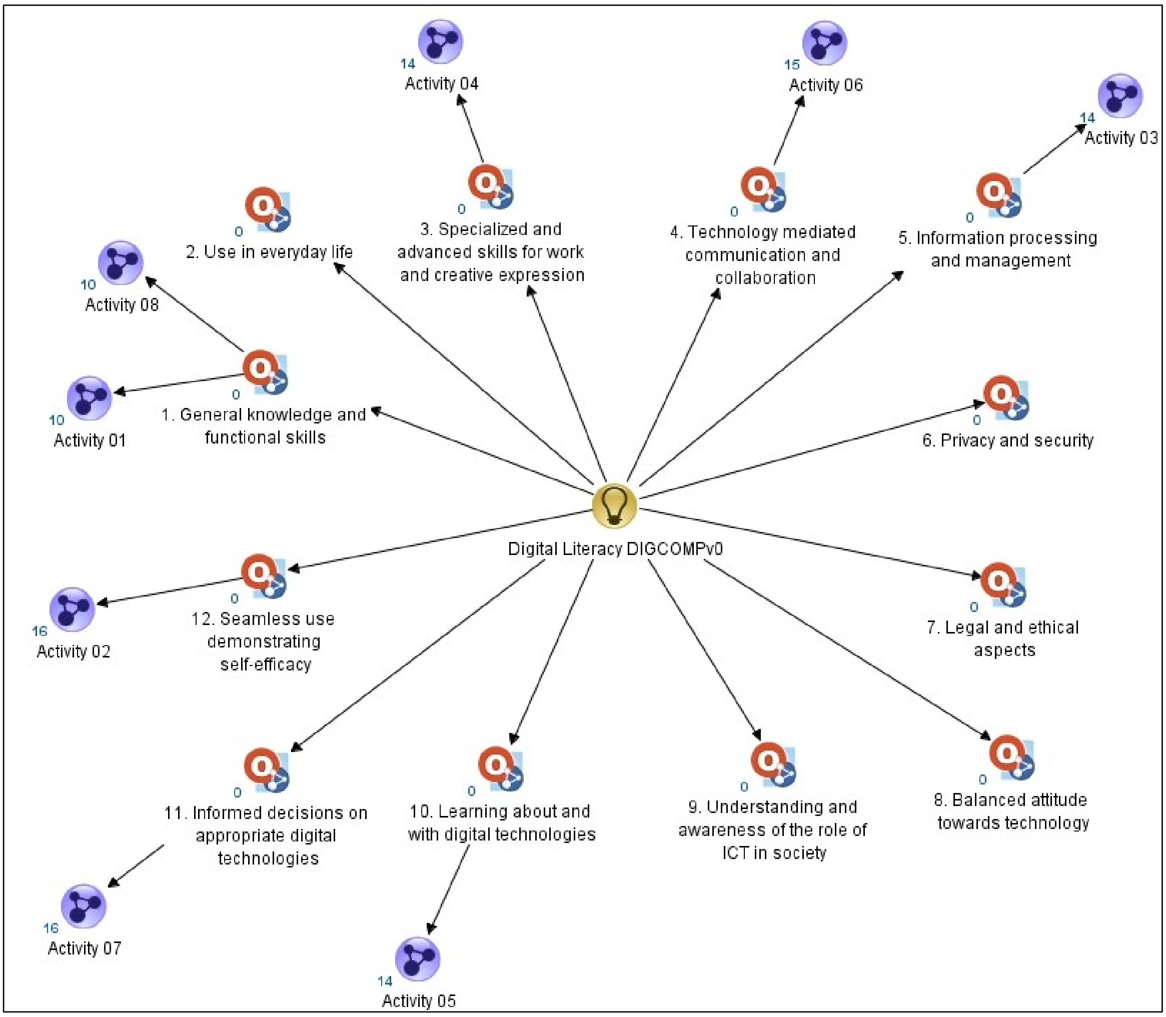


Figure 26 - The Online Learning Design Map DigComp$_{v0}$

The online learning designs of the technology-enhanced activities mapped onto the DigComp$_{v0}$ digital-literacy areas. The numbers next to the icons depicting activities, indicate the number of elements used for the design of each activity. This image was exported from the CompendiumLD learning design software (The Open University, 2011).

The online activities were defined by the required outcomes without the tasks being prescriptive of how they should be completed, or in relation to the technologies that should be used. This approach was considered as beneficial since students were expected to have a diverse set of technological skills and capabilities. As such the students were allowed to use a technology they were already familiar with, although they were strongly encouraged to be innovative and experimental in anything new. This decision was based on evidence resulting from the analysis of the interview data conducted in phase 1, and posthumously corroborated by the results of the digital-literacy self-assessment $\text{DigComp}_{\text{v0}}$ questionnaire.

There were eight online activities in total, of which the first and last (activities 1 & 8) documented the experiences of the students undertaking the intervention. The remaining six were created around a number of disciplinary-related and digitally-enhanced learning outcomes in an attempt to develop digital capabilities according to the digital-literacy areas identified in the $\text{DigComp}_{\text{v0}}$ framework. A variety of suitable, openly available technologies were suggested in conjunction with examples of institutionally supported technologies. The activity objectives derived from a combination of the desired disciplinary and technological learning outcomes. Technological training was provisioned on request throughout the intervention to ensure that the students were adequately supported. A graphical representation of a learning-design workflow is presented in Figure 27. Learning outcomes relevant to the curriculum requirements are identified as LO1 to LO3, and digital competency outcomes are denoted by the respective digital-literacy area which, in this case, is DL12 'Seamless use demonstrating self-efficacy'.

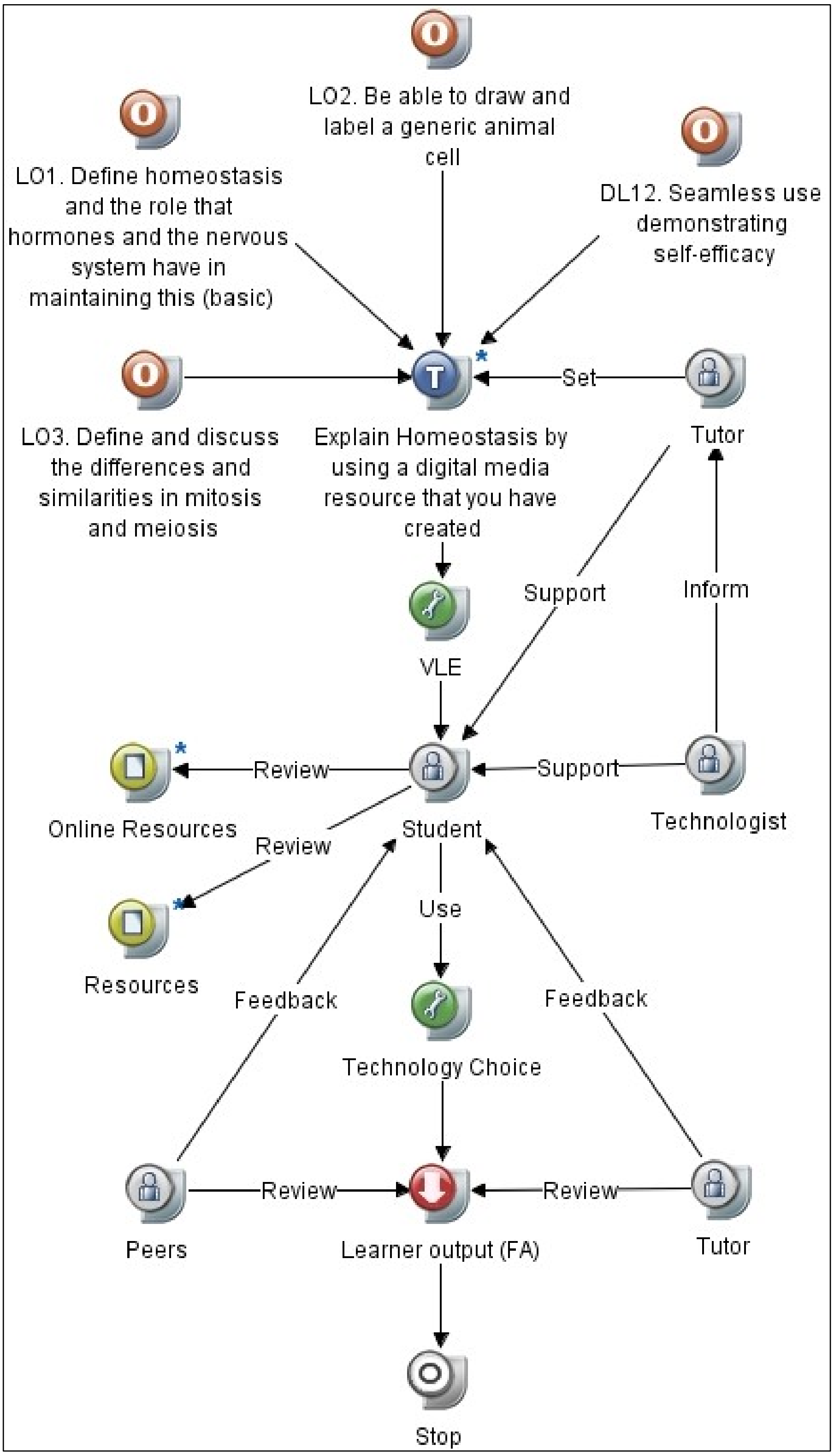


Figure 27 - Online Learning Design Activity 2

The design for the online learning activity 2 where all the necessary elements are identified. The disciplinary and digital-literacy learning outcomes are identified at the top, with the remaining elements appearing in a linear time-bound order.

The workflow diagram operates in a top to bottom fashion indicating the sequence of events from start to finish. In this activity students are asked to explain Homeostasis by creating a digital-media resource that meets the defined disciplinary and technological outcomes. A small number of resources with essential background information on the topic were provided, but students were encouraged to expand their research beyond the given resources. At this point the students had to make their own decisions about the technologies they would use to create the artefact. The tutor and the technologist - who in this instance was the primary researcher and author of this thesis - provided support when requested. The students were expected to share their created digital artefacts with peers and tutors who, in turn, provided feedback on the content and the presentation. The complete set of the activity descriptions and learning designs can be found in Appendix - Learning Designs.

4.2.5.1 The Student Experience

In the section that follows the student-experience of the participants undertaking the technology-enhanced learning activities was explored through analysis of the reflective diaries [ACTION_03] and the transcribed corpus of the focus groups [ACTION_04]. It was decided that only the themes commented on by most of the participants ($n > 10$) were included as they were considered to be representative of the group. The stacked bars in Figure 28 correspond to the number of references extracted from the focus group discussions and the reflective diaries for each theme. The numbers identified on the line labelled as 'individuals' denote the number of individuals that made a reference relevant to the theme.

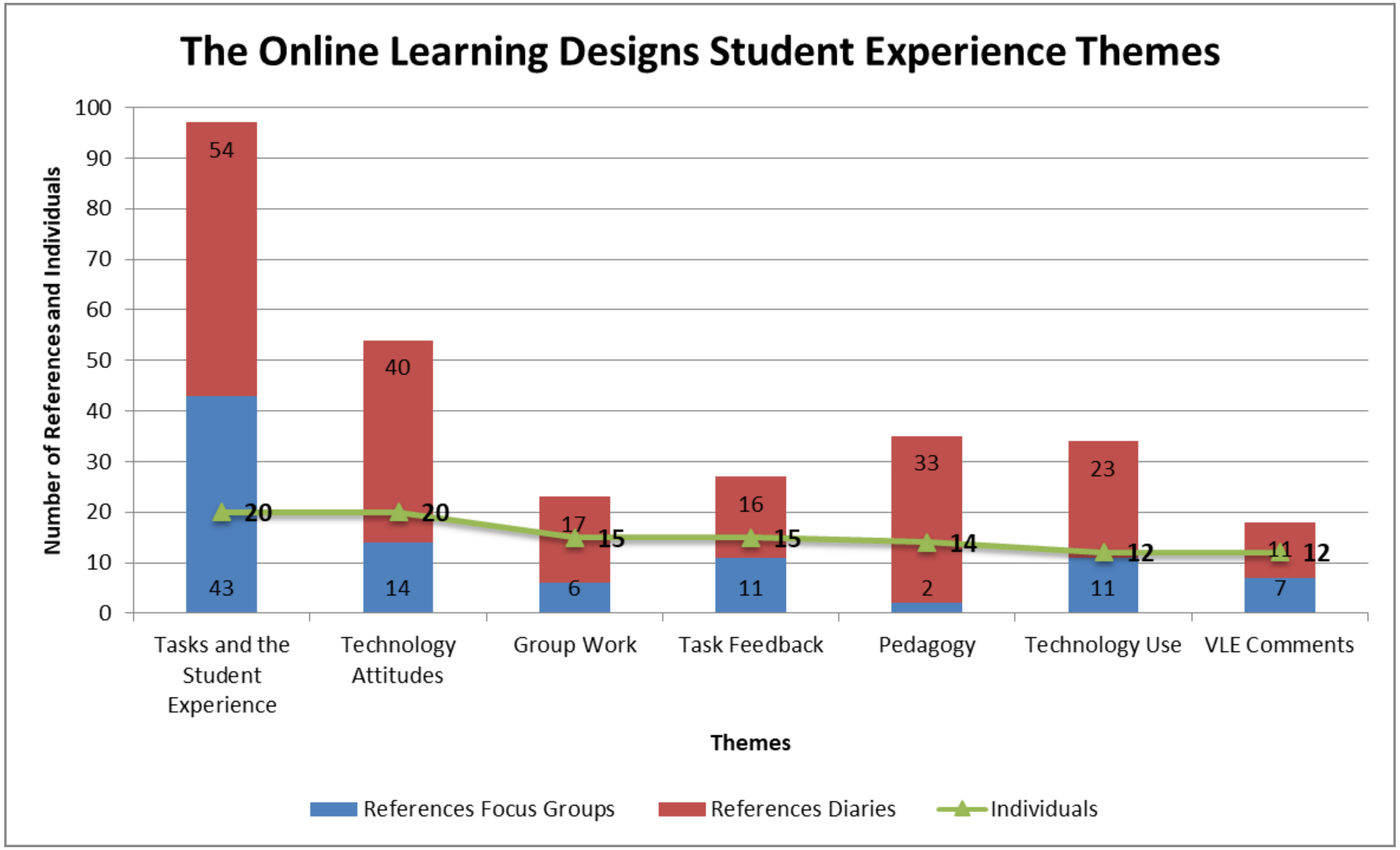


Figure 28 - The Online Learning Designs Student Experience Themes

Prominent themes arising from the analysis of the reflective diaries and focus groups arranged according to the number of individuals commenting on a theme indicating the number of comments from the focus groups and diaries. Only the themes mentioned by the majority ($n > 10$) of the participants were included as the rest could not be considered as representative.

The participants' specific comments on their experiences of undertaking the activities were summarised under the tasks and student experience theme. They commented that this type of delivery was enjoyable and motivating as it enabled them to learn at their own pace minimising the need to travel. The majority stated that they acquired or refreshed existing digital skills which increased their confidence in using technologies for learning. A small number, however, stated that the activities were not challenging enough and as a result they did not feel they had improved their digital capabilities. On the contrary, a small number of less digitally-capable students reported that they found the activities challenging. Many reported that they preferred the use of multimedia and interactive learning objects rather than the traditional text-based resources, as they found them more engaging. An important aspect was that most seemed to prefer the loose deadlines imposed, as this allowed them to learn at their own pace at a time convenient to them. A significant minority reported that they felt they developed self-directed learning, their research skills improved and, through these their independence improved. Commenting on the delivery format some students found the online delivery distracting as they preferred a more teacher-led instructional approach. A significant challenge was identified by some participants in managing their workloads due to competing commitments, such as formal assessments and clinical placement responsibilities.

When the attitudes towards technology were examined it was observed that there was substantial diversity in their self-reported experiences with some individuals reporting both negative and positive aspects on technology use. The participants reported that technologies enhanced the modes of communication, elevated their self-awareness and facilitated the realisation of personal and professional identities by commenting on the multiple modes of social-media participation and their varied use in professional and personal settings. Several students found the experience of utilising new technologies as rewarding, appreciated the challenging task that took them out of their comfort zone, and characterised it as useful in further developing their digital capabilities. Nevertheless, this view was not unanimous as some were less comfortable and reported that developing their digital skills was time-consuming. Significantly, some of the participants raised concerns around unqualified assumptions of the perceived benefits of technology-use as their experiences showed that the application of technology was not always efficient in terms of the required time and effort investment, while others maintained the opposite view. These comments were made explicit when some of the participants reflecting on their workplace experiences commented that the mere availability of technology does not equate to increased use or efficiency, especially when it is used within demanding or difficult situations such as those met in clinical practice.

Group work was considered to be a valuable and enjoyable experience as students reported that they got to know their colleagues better and learn together by sharing their knowledge and skills. Knowledge and research resource-sharing in the form of peer group exchanges was also highly valued as the participants felt that this enhanced their learning and broadened access to relevant resources. Working collaboratively also enabled the students to take charge of their learning by having to manage the logistics of working in a group. For example, some groups shared responsibilities equally, whilst others defined roles and allocated responsibilities within their respective teams according to the perceived strengths of the individuals. A small number of students reported that working in a group was challenging as they had to commute in order to meet, and this required additional time. Nevertheless, they reported a positive overall experience finding the activities engaging and meaningful for their learning.

Many of the participants expressed strong views on the provision of feedback on the tasks including a mixture of positive and negative comments. Some reported receiving positive, timely and meaningful feedback, but others reported just the contrary. That, in cases, there were significant delays in receiving their feedback. The mode of feedback was also commented upon. Some stated that they would rather receive feedback in a more immediate and embedded manner. Interestingly, students suggested that they preferred to see model examples of the required task-outputs as these would enable them to understand the type and depth of the work required.

Comments relating to pedagogies in relation to the students' digital-literacy development focused on the added value of the tasks that were naturally linked to their topic of study. They particularly welcomed the honing of information and research competences as they had been encouraged to search, evaluate and critically analyse information that was discovered through a variety of sources and in a variety of formats that included a significant number of digital resources. It was also evident from their examples that they utilised a variety of resources that matched their individual learning preferences including audio-visual material, images, and diagrams in addition to text-based resources. The inclusion of suggested resources was useful to get them started but most of them identified additional resources. There was broad consensus that independent self-directed learning, when mixed with directed-learning, was the preferred learning mode. However, some were uncomfortable in finding their own resources as these were in need of careful evaluation, and preferred to be given tutor-reviewed and approved resources. It was interesting to observe evidence of pedagogic development in practice when one of the participants reported that the activities helped them to become more confident and independent in the use of technologies when initially they had been apprehensive.

Technology-use examples revealed that a variety of digital devices were used with some of the participants reporting the utilisation of multiple devices and platforms. Their comments focused on the achieving of balance between developing their digital skills and not spending too much time in doing so, as this was considered to be potentially detrimental to their studies. This topic was highly contentious with some participants commenting in favour of spending more time to develop their digital skills and some expressing exactly the opposite opinion. Participants recounted how enthusiastic they were to use new technologies creatively, but as their other study commitments increased, they reverted back to using technologies they were already familiar with, thus losing the opportunity to enrich their digital skill-set. Some found the technical elements of the activities challenging and turned to family or friends in order to learn how to use them.

Some of the participants commenting on the use of the Virtual Learning Environment (VLE) reported that it was user-friendly and accessible. It enabled them to work collaboratively, share resources and review the work of their peers. However, a large number reported that they encountered problems when they tried to share multimedia in the form of audio and video outputs they had created. On further investigation it was discovered that this was due to technical limitations of the system, and alternative ways to share these resources were provided. During the investigation it was also discovered that the VLE was not optimised for mobile technologies as the layout was not ideal for use with smaller screen sizes, and the lack of traditional inputting devices such as a mouse and keyboards.

4.2.6 Discussion and Conclusion

The objective of this exploratory and innovative phase of the research was to investigate whether a digital-literacy framework approach could be used to support student learning and explore the ways it could be employed to enhance digital literacy. In this second intervention

(intervention 2) the DigComp_{v0} framework was used to guide the design of a number of learning activities that embedded digital literacy in the curriculum. At the same time the digital literacy self-assessment questionnaire based on the DigComp_{v0} framework previously developed in intervention 1 was issued to students ($n = 102$) in order to collect data for the analysis of its validity and in an attempt to explore the possibilities of benchmarking their digital capabilities. In addition the student experience was documented by asking the students to complete reflective diaries ($n = 20$) of their experiences when undertaking these activities and when conducting focus groups ($n = 32$).

Evaluating the results of the validity analysis of the questionnaire that have been reported in a previous section of this chapter, indicated that the approach of using the DigComp_{v0} framework to quantify digital literacy was a viable option but not without certain drawbacks. The response format employing an agreement/disagreement scale was based on a subjective evaluation of the digital capabilities of the participants (Carifio and Perla, 2007). This fact, compounded by institutionally imposed constraints, limited the scope for assessing the validity by testing/re-testing (Elkin, 2011). It was also discovered that, although the questionnaire was highly internally consistent, there were significant ceiling effects indicating that the resolution of the response format was not sufficient (Salkind, 2010; Hessling, Traxel and Schmidt, 2011). Finally, the questionnaire was rather long, comprising of sixty questions and as Rolstad, Adler and Rydén (2011) suggested this might have a negative impact on the participation rate, although the results of their meta-analysis were inconclusive. Despite these drawbacks, the application of the questionnaire into practice showed that it could be used successfully to benchmark the digital-literacy group characteristics (Evangelinos and Holley, 2014b). However, it could not be assumed to be a robust measuring tool for assessing digital literacy in absolute terms. For these reasons, it was decided that the response format, the language and the number of questions had to be revised. As a result the questionnaire had to be re-evaluated.

Scrutinising the student experience as it ensued from the analysis of the reflective diaries and the focus groups demonstrated that digital literacy can be developed through the purposeful design of technology-enhanced learning activities as most students reported increased confidence in using technologies. However, a closer analysis of the student responses indicated that this was a complex process as they had diverse digital preferences and capabilities (Gilbert, Morton and Rowley, 2007). Therefore, it is important the learning activities to be designed in a way relevant to the discipline and the content of the curriculum as this is an efficient way to maximise the benefit of acquiring enhanced technological capabilities (Thomson et al., 2014). Moreover, a flexible design process could facilitate the embedding of digital literacy in the curriculum by designing a variety of learning opportunities that embed a wide gamut of digital skills within the disciplinary context (Galley, 2011). Students valued collaborative learning opportunities and stated that they learn from each other, a behaviour identified in cognitive-enhancement literature (Pask, 1975) and when learning in groups within higher education environments (Laurillard, 2002). Most participants agreed they preferred a mixture of self-directed and tutor-led learning experiences that resonate with the theoretical conjectures of Mayes and Freitas (2013) for the value of multiple pedagogies.

A significant challenge in participating was reported by the students in that, due to competing curriculum commitments, they found it difficult to engage as their formal assessments and clinical placement responsibilities put pressure on their available time. The lack of allocated time to complete the activities was a noteworthy issue that could be addressed by formally embedding these activities in the curriculum delivery. Indeed research on online learning suggests that when these activities are formally scheduled, students report improved online learning experiences (Hill, 2002). Some students reported delays in receiving feedback on the tasks but this is often the case with asynchronous learning (Petrides, 2002; Vonderwell, 2003). Timely provision of feedback can be achieved when the necessary resources, such as academic staff time, are protected and an online teaching schedule is established. This could be achieved by building the activities as part of the formative and summative assessments, reward participation and ring-fence the time-resource for marking and feedback. Another criticism on the learning activities was that the tasks were not specific enough. This was a conscious decision of the academic team and the researcher to allow flexibility in the interpretation of the digital requirements and not to be overly prescriptive and restrict student creativity. Moreover, the digital capabilities of the student group were unknown at the time of authoring the activities and more precise definitions would have risked making the activities inaccessible to the digitally less capable students or meaningless for the more advanced ones.

The participants evaluated the interventions as stimulating, meaningful and beneficial for their learning. However, a number of improvements that could enhance the student experience have been identified. Ideally, the digital-literacy potential of the students should be ascertained from the outset so as to inform the design process. The delivery of the activities should be accounted for in the formal timetable, and recognised through formal and informal accreditation schemes. Efficiencies in terms of learning development could be achieved when the students develop their technological capabilities in the context of their disciplinary studies. Learning activities should be carefully designed and their delivery should be facilitated and supported in both academic and technological domains. The design process should enable personalisation and the flexible delivery of digital skills so that every student enjoys the maximum benefit irrespective of their starting point. One way to personalise the design is by increasing the number of activities targeting at different levels of digital capabilities. However, this will demand increased resources in terms of time and effort at the design stage. Alternatively, the activities could be designed flexibly, so as to allow students to produce work requiring different levels of digital capability. As this will considerably complicate the activity development a robust method, processes and tools for embedding digital literacy in the curriculum will be needed, including the provision of an appropriate programme of professional development.

Examining the qualitative and quantitative data of this exploratory phase (Phase 1) it was apparent that there were no distinct correlations of any characteristics that could be attributed to the healthcare discipline, especially when this was considered in terms of clinical practice. The participants of the research were given ample opportunities to reflect on technology use in the workplace, including the clinical environment. Yet, they primarily reflected on examples that were broadly personal, or private use, and to a lesser degree from their academic life, whether students, academics or academic-related professionals. Initially, it was assumed that the academic staff would readily draw from their professional experiences in clinical practice but this was not the case. Similarly, the analysis of the students' reflective accounts have not shown any apparent link between digital literacy and their future healthcare-professional identity. However, the more generic traits, classified in the DigComp framework are broadly relevant to any discipline including healthcare and medical sciences. In addition, the learning design approach and the digital-literacy questionnaire tool have shown to be transferrable in other contexts and have exhibited promising results in quantifying digital literacy.

Considering the findings as to how these could be used to address research question 1.1 (Q1.1) in particular, and identify any disciplinary-specific digital-literacy characteristics within healthcare education, the following became apparent. The strategic decision made in the early stages of the research design to exclude stakeholders from clinical practice because of access issues and other logistical and ethical concerns, limited the transferability of the results to the clinical healthcare professional-education sector. In this respect the research question (Q1.1) was answered only in the context of a tertiary healthcare-education environment. This research decision was justifiable since the DigComp_{v0} framework was still under development and the aim was to test its applicability. Exploring the abstracted conceptualisations, structure and process in implementing the framework were intrinsic objectives of what was meant to be tested as part of the inquiry. Admittedly, the choice of the research design restricted the types of analysis since the framework was designed for non-experts. This methodological tension elicited results that were not applicable to the clinical-healthcare professional-education environment.

To some extent this apparent tension could be attributed to the fact that, at that time, the main driver behind the healthcare-workforce development in the UK, was a framework for technology-enhanced learning, aiming to enhance patient-care outcomes by ensuring a highly qualified workforce (Department of Health, 2011). However, this was not a digital-literacy development framework. It was only during the later phases of the research that a concerted effort was made to systematically enhance the digital capabilities of the healthcare workforce through the Personalised Health and Care 2020 plan (NHS England, 2014; National Information Board, 2014).

4.3 Overall Conclusions and Next Steps

In this exploratory research phase the $DigComp_{v0}$ digital-literacy framework was evaluated for its suitability to define and quantify the digital literacies of learners, teachers and academic-related professionals in the context of tertiary healthcare education. During this initial exploration phase, the question of whether there were any healthcare-specific attributes arose naturally. In an attempt to establish a common frame of reference, the conceptualisations, structure and definitions of the framework were explored qualitatively by interviewing a total of 12 health-care students, academics and academic-related professionals (Intervention 1). The analysis of the interview data revealed that the digital attitudes of learners and healthcare-education professionals were coherent with the framework conceptualisations. The mapping of the significant themes of the lived experiences of the healthcare-education stakeholders showed that the classifications, structures and skilled definitions were adequate, although not necessarily ideal (Evangelinos and Holley, 2014a). A thematic analysis indicated some limited commonalities, but these could not be directly attributed to specific healthcare practices. Notably, the individuals reported highly-varied, technology-use patterns and attitudes towards technology. The results suggested that a structured framework approach could be used to understand how digital literacies manifest in student learning experiences.

Having established that the framework could be utilised to describe digital literacy in local practice, its suitability to be used as the basis for establishing a design approach to embed digital literacy in the healthcare curriculum and formulate a tool to quantify their digital capabilities (Evangelinos and Holley, 2014b), was also explored (Intervention 2). During intervention 2 the student experience when undertaking a series of technology-enabled online activities contextualised within the healthcare curriculum was evaluated. The results showed that the activities were beneficial for learning and digital-capability development as self-reported by the participants. Furthermore, their delivery identified a number of implementation challenges and areas for improvement. As per the above quantification of the digital literacy by utilisation of the bespoke self-assessment tool, based on the same framework approach, appeared as consistent but further work was needed to establish its validity and robustness.

During the time phase one of the research was being carried out, the DigComp framework was published in a significantly revised but broadly compatible format that addressed the structural challenges previously identified (Evangelinos and Holley, 2015a). Therefore, it deemed as necessary to update the framework structures, the self-assessment tool, and review and re-evaluate the design approach as it is reported in phase two. The chapter that follows reports the evaluation of the design approach applied to different learning-scenarios utilising the updated structure and self-assessment tool.

Chapter 5. Phase 2 – Review and Enhance

This chapter reports on the second phase of the research [ACTIONS_06 - 10] that utilised an improved approach to quantify the digital capabilities of students and academic staff and explored the student experience. Phase 2 comprised of the re-working of the digital-literacy self-assessment questionnaire to reflect the structure of the DigComp$_{v1}$ framework (Ferrari, 2013) and utilise a new scenario-based approach in an attempt to produce more accurate and repeatable results. This updated questionnaire was used, alongside a survey of the student experience of using digital technologies, to assess the digital literacy of students in a separate project piloting the use of tablet devices to record their clinical-competence assessments in practice. A staff-specific version of the questionnaire was developed following the same format but merged with additional questions for the assessment of their professional digital practices. It was administered to academic staff with the aim at investigating the potentials and limitations of measuring their digital capabilities as these are a key in developing the students' digital literacy. This research phase concluded with the assessment of the digital literacies and experiences of students when technology-enhanced learning designs were delivered in the classroom. Similarly to Phase 1, research question 2 was included again to investigate the learning experiences of students and establish an approach that could develop their digital literacies.

Q.2 In what ways can a framework approach assist us to understand how digital literacies manifest in student learning experiences?

Q.2.1 How can digital literacy be developed in a higher education healthcare environment?

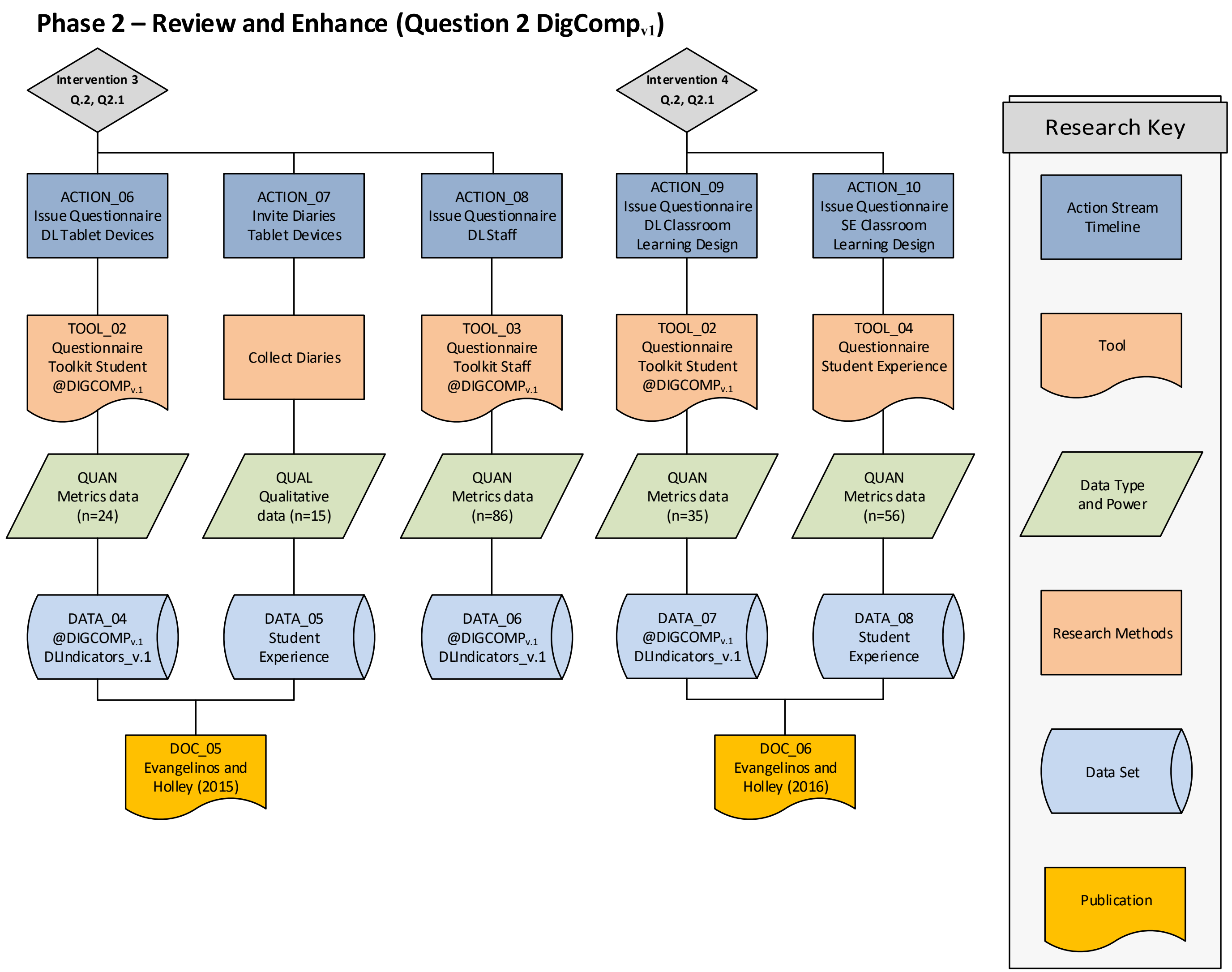


Figure 29 - Phase 2 Research Design

This phase of the research commenced with intervention 3 by offering [ACTION_06] the self-assessment questionnaire [TOOL_02] to an additional group of nursing students in order to explore their digital-literacy characteristics and experiences on using technologies (intervention 3). The participants ($n = 24$) self-assessed their level of digital literacy and declared their digital engagement. In order to explore the digital-engagement profiles and experiences of the participants they were further invited [ACTION_07] to complete a short diary reflecting on how they used technologies in their everyday lives including work, study and leisure. A sub-group of the participants ($n = 15$) completed the diaries which were analysed to reveal authentic examples of the types of digital engagement. The staff-oriented version of the digital-literacy self-assessment tool [TOOL_03] was assessed [ACTION_08] by examining the voluntary replies of academic staff ($n = 86$). This staff-tailored version was used to assess the performance and validity of this revised questionnaire. The development of a tool to assess the digital capabilities of academic staff was important, as they are key stakeholders in the developing the digital literacy of students.

Following the same methodological approach as the one employed previously (intervention 2) the research proceeded with offering [ACTION_09] the student-version of the questionnaire [TOOL_02] to a group of student Midwives to evaluate their digital skills. Again an evaluation [ACTION_10] of the participants' experiences, when undertaking technology-enabled activities in the classroom, was conducted by issuing a short questionnaire [TOOL_04] to evaluate their experiences. The activities had been designed by following the same methodological approach as in phase 1 where the academic team, in liaison with the primary researcher and author of this thesis, designed authentic learning activities to deliver the learning outcomes of the disciplinary curriculum and engage students in learning within the classroom through the utilisation of appropriate technology.

5.1 Intervention 3 (Actions 6 & 7): Investigating the Digital Literacy Needs of Healthcare Students when Using Mobile Tablet Devices for the Assessment of Student-nurse Competency in Clinical Practice

The digital-literacy developmental needs, skills and attitudes of nursing students ($n = 24$) were investigated when tablet devices were used to assess their competencies in clinical practice. The research was conducted as ancillary to a separate project which piloted the use of tablet devices and an electronic application-based portfolio. Students were asked to complete the self-assessment questionnaire to benchmark their digital literacy. The characteristics of the participants were explored through their comments ($n = 15$) in the reflective diaries.

5.1.1 Methods

The participants completed a revised skills-based online self-assessment questionnaire [TOOL_02] enabling the benchmarking of the digital capabilities of the group. Previous work from Evangelinos and Holley (2014a) had found that the data produced by the DigComp$_{v0}$ questionnaire [TOOL_01] showed that the response format, based on a self-assessed agreement/disagreement scale, produced subjective results that were not necessarily repeatable. The revised questionnaire was based on the EU DigComp$_{v1}$ framework (Ferrari, 2013) and included 21 competencies organised into 5 themes, as these can be seen in Table 24. Each question presented the participants with four examples of possible, hypothetical technology-use scenarios that progressively became more complex and were asked to select the answer that best matched their skills. Participants had to reflect on their skills and attitudes and select an answer irrespective of having actually completed similar activities in the past. The scenarios were tailored to present the students with authentic situations relevant to their academic experiences by providing examples relevant to academic study representing different digital-capability levels ranging from lack of skills to basic, intermediate and advanced. These were measured on a scale from 0-3 where a value of 0 indicates no skills, (>0 and <=1) denotes basic competency, (>1 and <=2) intermediate and (>2 and <=3) is considered as advanced.

Digital Literacy Areas DigComp$_{v1}$ Framework	
1. Information 1.1 - Browsing, searching and filtering information 1.2 - Evaluating information 1.3 - Storing and retrieving information	**4. Safety** 4.1 - Protecting devices 4.2 - Protecting personal data 4.3 - Protecting health 4.4 - Protecting the environment
2. Communication 2.1 - Interacting through technologies 2.2 - Sharing information and content 2.3 - Engaging in online citizenship 2.4 - Collaborating through digital channels 2.5 - Netiquette 2.6 - Managing digital identity	**5. Problem solving** 5.1 - Solving technical problems 5.2 - Identifying needs and technological responses 5.3 - Innovating and creatively using technology 5.4 - Identification of digital competence gaps
3. Content creation 3.1 - Developing content 3.2 - Integrating and re-elaborating 3.3 - Copyright and licences 3.4 - Programming	

Table 24 - Digital Literacy Areas DigComp$_{v1}$ Framework

The DigComp$_{v1}$ digital-literacy areas as described in DigComp: A Framework for Developing and Understanding Digital Competence in Europe (Ferrari, 2013).

An example of the scenario-based questions can be seen in Figure 30. The complete questionnaire tool, based on the DigComp$_{v1}$ framework, can be found in Appendix - TOOL_02 DL Questionnaire DigComp$_{v1}$ Student.

* 5. 2.1 Communication - Interacting through technologies

- I use a chat or a discussion forum to communicate with other students on my course.
- I use a chat to communicate with other students, when necessary I can also use a group chat and moderate it. When needed, I also use audio-video conference tools to talk to other students.
- I use several communication tools to communicate with other students (mobile phone, audio-video conference tools, chat or email). I use several features of audio-video conference tools – when I work on a project with other students: I can use screen share feature, I can also record a conversation and broadcast it. I know which communication tool to select, depending on the purpose and the size of the audience.
- I don't have the skills to complete any of the above.

Figure 30 - The DigComp$_{v1}$ Question Example for Communication: Interacting through technologies

It should be noted that each digital-literacy area as seen in Table 24 was constituted of different numbers of scenarios resulting from a decision to strictly follow the DigComp$_{v1}$ framework structure. For example, the information digital-literacy area was comprised of three information-literacy sub-questions, the communication area was expressed by six, and content-creation, safety, and problem solving were represented by four questions each. For this reason, the values arising from the individual questions were averaged together for each high-level digital-literacy area to give a comparable metric at the analysis stage. Therefore, the group digital-literacy maps represent the digital-literacy potential for each high-level area, expressed as a weighted index, which was the mean value across a number of competence-specific scenarios.

An exploration of the student experience of utilising tablet devices for the assessment of their competencies in clinical practice was carried out by inviting the participants [ACTION_07] to complete short reflective diaries ($n = 15$). The diaries documented their technology-use experiences in their private, academic and work lives, as well as their perceptions of digital literacy. The participants critically commented on their experiences of acquiring digital skills, identified areas for improvement and offered suggestions on how the institution could assist in further developing their digital skills. The analysis was conducted following the same approach as in phase 1 by using QSR NVivo 10 software and coding the reflective diaries into themes, following the coding recommendations of Miles and Huberman (1994) and Guest et al (2012).

5.1.2 Results

The data resulting from the application of the revised questionnaire to this group of students [ACTION_06] were explored to assess its usefulness in benchmarking the digital-literacy of the participants from a practical perspective and explore their experiences of using technologies through reflective diaries. The analysis was not conducted at the same depth as in the previous phase for reasons of brevity and because the number of participants completing the questionnaire ($n = 24$) and the diaries ($n = 15$) was relatively small and it was not considered to be sufficient. For this reason, the validity of the questionnaire tool was examined indirectly, by analysing the results of the staff-specific version [ACTION_08] which had a larger number of participants ($n = 86$). However, a brief analysis was carried out to explore whether the quantitative and qualitative data supported the applicability of the tool, and investigate the practical implications of employing the revised questionnaire in practice.

From a practical perspective, the average (mean) values of the group for each digital-literacy area, seen in Figure 31, can be used to evaluate the overall group competency. Specifically, the information index for the participant group with an average of (2.17) points signifies that students, as a group, have just above an intermediate self-declared competency in the information digital-literacy area. In contrast, the average value of (1.65) for the content-creation area indicates that the group was least confident in this area, self-declaring basic competence. In addition, an analysis of the group's digital-literacy potential distributions was carried out to explore the individual characteristics of the group. The analysis disaggregated the group results and rendered beginner, intermediate or advanced skills to the individuals. As shown in Figure 32 the digital-literacy capabilities of the group, when examined per each area, considerably varied. Inspecting the best and worst performing competence areas in more detail it was observed that all of the participants had above intermediate competency in the area of information, but one in three self-declared basic competency in content creation. This type of analysis can be used to identify areas of interest, for example when targeting training or personalising the design of technology-enhanced learning activities.

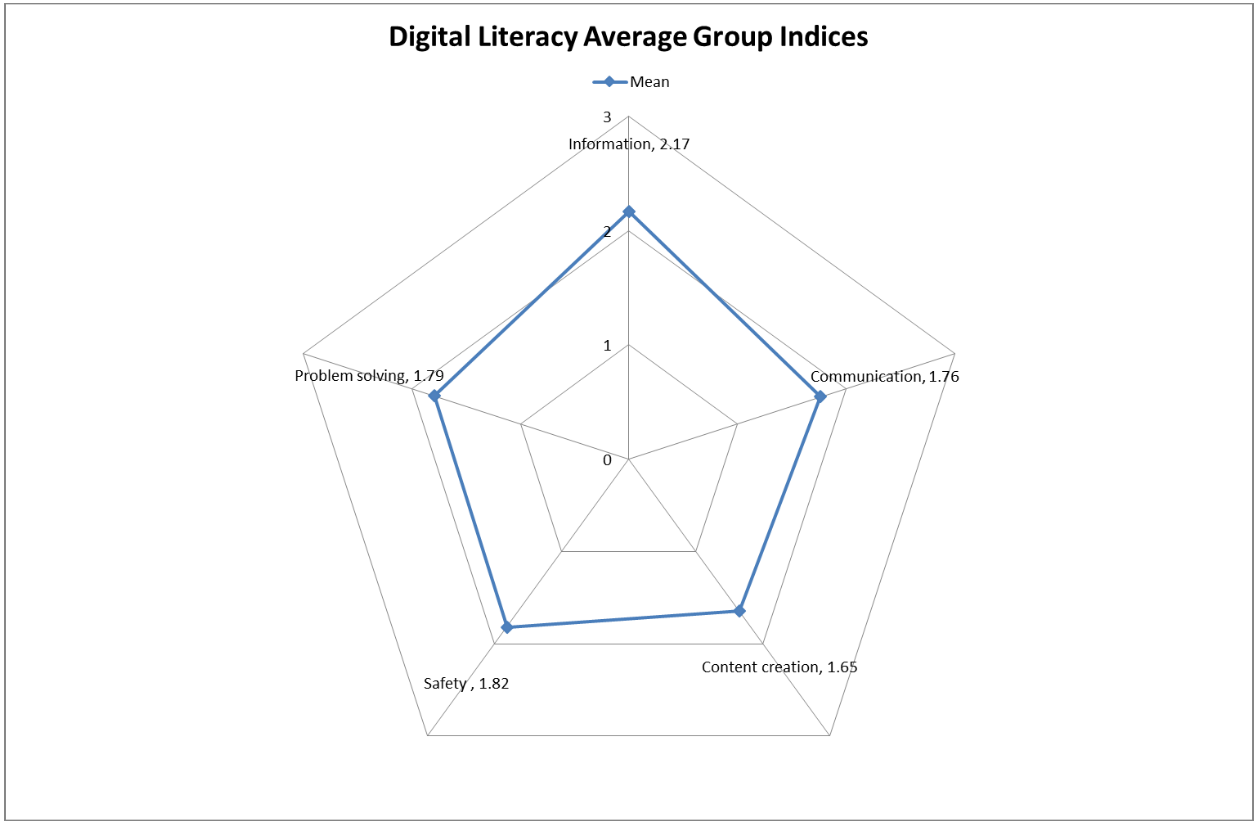


Figure 31 - Digital Literacy Average Group Indices (Intervention 3)

The average (mean) group indices for each DigComp$_{V1}$ digital-literacy area. These were measured on a scale from 0-3 where a value of 0 indicates no skills, (>0 and <=1) denotes basic competency, (>1 and <=2) intermediate and (>2 and <=3) is considered as advanced. These data show the group was overall digitally competent exhibiting an above intermediate competency in the area of information with the rest of the areas being close to the upper boundary of intermediate. This information is useful as a benchmark of the overall digital capability of the group.

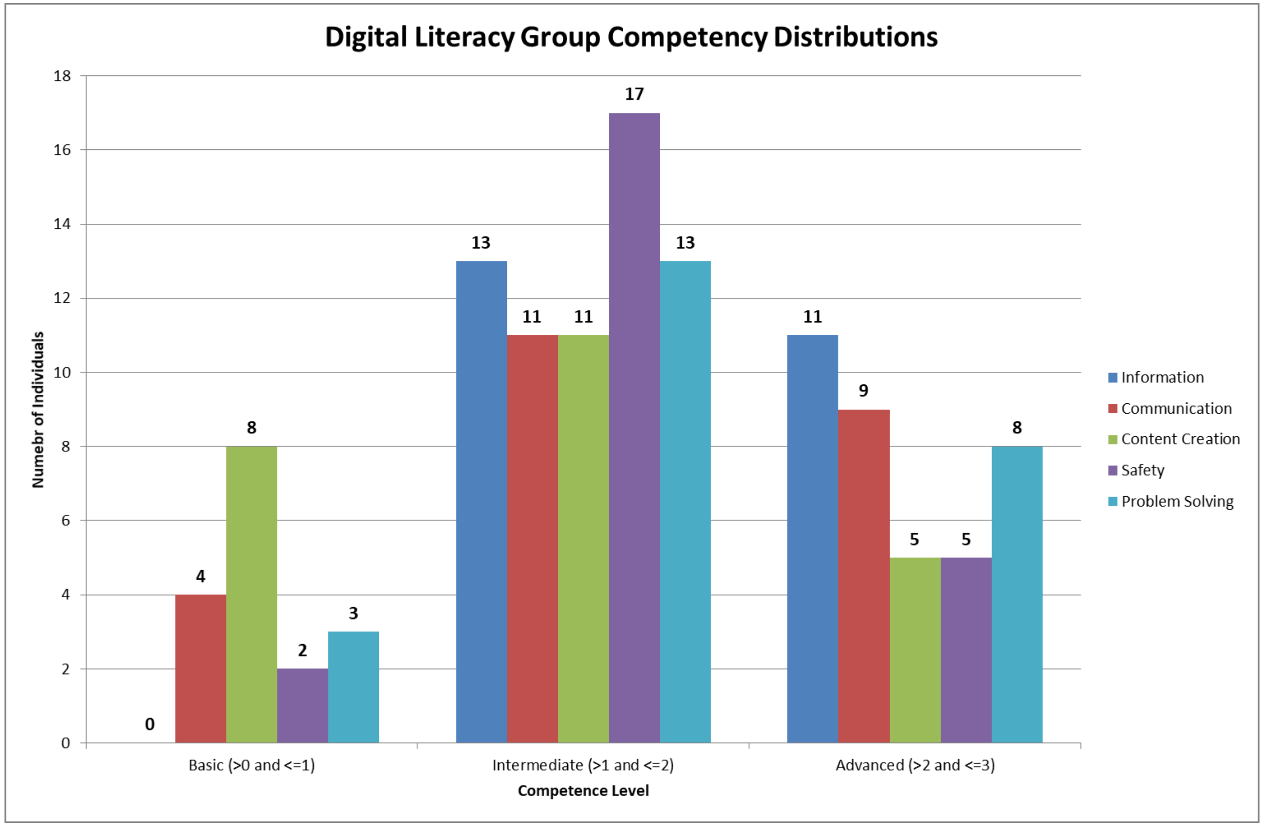


Figure 32 - Digital Literacy Group Competency Distributions (Intervention 3)

The group distributions for each DigComp$_{v1}$ digital-literacy area derived from the number of individuals. These were measured on a scale from 0-3 where a value of 0 indicates no skills, (>0 and <=1) denotes basic competency, (>1 and <=2) intermediate and (>2 and <=3) is considered as advanced. The data shows the distributions of the participants with basic, intermediate and advanced digital competency for each digital-literacy area. This type of analysis is useful when detail is needed on the exact numbers of individuals, for example, when considering the targeting of training or personalisation of digitally-enhanced learning activities.

Twelve weeks after the students were given tablets and completed the questionnaire they were asked to consider their digital-literacy learning and development cycle and critically document their experiences on using mobile tablet digital-technologies and learning through them in their a) private b) academic and c) work lives. The analysis of the reflective diaries identified significant themes commented on by the majority of the participants that can be seen in Table 25. The numbers next to each theme indicate the number of individuals commenting on a theme.

Thematic analysis of the reflective diaries demonstrated that the participants in private life, are concerned primarily with communication (11), usability (11), and experience (9). Social networking and communicating with friends and family when travelling or being on the move was one of the most appreciated affordances of technology. Students also use mobile digital technologies to access systems for carrying out everyday activities, including communication and interacting with the university. They expect a seamless experience when accessing systems from their smart phones or tablets and expect to be supported when things do not work properly.

Conversely, exploring their experiences in academic life they are concerned with experience (12), usage (11) and information (8) indicating the main areas of interest relevant to healthcare education. The majority of the participants admitted that technology engagement for higher education study is a necessity and that they generally feel comfortable in using more than one type of technology. Tablet and smart phone use was widespread and, although some individuals admitted they were lacking the necessary skills for making effective use, they were willing to acquire the missing competences and skills. The main usage-patterns included the use of subject-specific apps to acquire knowledge, tablet apps for note taking, access university information and timetabling, and e-submission of the required assessments of nurse competencies. From the perspective of acquiring information, mobile technologies are used for exam revisions, information retrieval online that includes books, journals and websites enabling the users' studies. Eight students emphasised the value of using tablet devices within lectures to broaden their understanding, check facts and definitions, or review and focus their study on difficult concepts.

Private Life	Individuals	Academic Life	Individuals	Work Life	Individuals
Communication	**11**	**Experience**	**12**	**Experience**	**10**
Usability	**11**	**Usage**	**11**	**Communication**	**8**
Experience	**9**	**Information**	**8**	**Organisation**	**8**
Tablet Advantages	6	Advantages	6	Usage	7
Information	6	Organisation	3	Advantages	4
e-Commerce	5	Disadvantages	2	Information	3
Tablet Disadvantages	4	e-Commerce	1	Disadvantages	3
Leisure	4	Media	1	Security	1
Organisation	3	Communication	1		
Media	2				

Table 25 - Diary Themes (Intervention 3)

The themes resulting from the thematic analysis of the reflective diaries for the areas of private, academic and work lives. The number of individuals commenting on a theme is noted to indicate the relative power. Only themes that have been commented on by the majority of the diary participants have been explored as they can be considered representative of the views of the group.

Similarly, in their work lives, technology experience (10), communication (8), and organisation (8) were the top three categories of interest. There is consensus that mobile technologies are becoming increasingly pervasive in all aspects of everyday life including work and usage in the workplace. Participants generally felt comfortable with using the tablet devices for work and they drew examples on how these tablets were successfully used for data entry in restaurants. The participants also reported that similar applications of technology could potentially change their work attitudes. From the communication perspective, they generally found it useful to have access to technology when in clinical placements as they often needed to access information and/or communicate with the university and their tutors. Examples of organisational implications of technology-use in the workplace include the use of mobile devices, applications such as the calendar, reminders which are used to manage diaries, and the setting of work-related reminders and notes.

5.1.3 Discussion

This multi-method approach gathered two sets of data: a) the digital-literacy quantitative indicators and technology-use distributions and b) the reflective diaries where students self-reflected on their digital-literacy affordances. At a group level, the quantitative metrics documented a snap-shot of the digital competences, skills and attitudes as defined by the DigComp$_{v1}$ framework. Students as a group seemed to be reasonably comfortable with the use of technologies to communicate, learn, and research. They generally engage with technologies in a number of ways. On the whole they showed a command of above-basic digital competency located at the borderline of intermediate. This type of analysis is of interest for the optimisation of the curriculum design and delivery. It must be stressed that the purpose of this intervention at this stage of the research was the consideration of the student experience and benchmarking of the group dynamics, and not a robust assessment of the individual digital capabilities as it has been eluded in earlier chapters.

Nonetheless, the quantitative data showed that this method offers possibilities for early identification of students with advanced digital skills, and of others who lack even basic and essential digital skills. In the latter case the potential offered in the classroom for early intervention is significant, as well as the chances that exist for utilisation and further development of those who possess advanced skills. In relation to teaching, when these situations are identified, they present opportunities for the construction of more balanced groups that will scaffold the informal learning of digital skills by considering the

Vygotskyian (1978b) ideas of ‘the more capable peer’. Examining the related digital skills, the group seemed less comfortable in the areas of content creation, communication and problem solving, while declaring more competent in information management and safety. The research diaries documented intricate details of the individual competences, skills and attitudes and allowed for the appreciation of the main areas of the students’ focus. Their qualitative analysis established that students faced academic life as a part of their everyday life, and practice placements as their workplace. However, these distinctions were considered arbitrary as most students reflected from their individual circumstances and experiences. What mattered to them was the way they individually used technology to achieve their own aims in their own private, academic and work lives, and this offered valuable insights to the academics seeking to design curricula that support the student learning.

5.1.4 Conclusion

In conclusion, metrics for defining and measuring digital literacies in higher education were developed according to the definitions of the DigComp$_{v1}$ framework following the same research approach established in the earlier research phase and discussed in previous chapters. The metrics could offer descriptors of digital literacy and when combined with an analysis of examples of technology-use, in the areas identified from the diary analysis, they can be used to inform the design of learning opportunities that participants will be familiar with, utilising a combination of formal and informal learning within their private, workplace and academic contexts. There is evidence that previous experience of technology, and computer skills are two important factors for formulating positive attitudes towards technologies, esential for developing one’s own digital literacy (Alquraini, Alhashem, Shah and Chowdhury, 2007).

The findings of the previous research phase, revealing that the individual’s digital competency was also affected by access to formal and informal peer-support networks, were also reinforced. Participants who could turn to someone for technological advice, such as a family member or informed friend, were more likely to have positive attitudes towards the use of technology, although there was no evidence that this resulted in higher levels of digital literacy. This conclusion is supported by the findings of the work of Davis (1989) and Roca and Gagné (2008) concluding that competence, autonomy and relevancy are associated with technology acceptance. Thus, formal or informal individual support indirectly increases their positive attitudes towards technology and the chances of adoption. Edmunds, Thorpe and Conole (2012) identified additional factors affecting the student attitudes towards technology, such as the perceived ease of use and usefulness. Therefore, it is important to cultivate a supportive environment, encourage autonomy and introduce meaningful technologies that are easy to use. This is becoming increasingly important as technological innovation and change necessitates the individuals to become self-sufficient and able to develop their digital skills on their own, so as to be able to use technologies with minimal support.

As it has already been discussed digital competency is acquired more efficiently when technology-enabled tasks are contextualised in terms of a discipline within the boundaries of producing specific outcomes that fulfil authentic needs. Therefore, it is important the teaching processes to be optimised so as digital skills to be acquired and assessed within the disciplinary curriculum. One of the essential enablers for formulating these processes is the quantification of the digital-literacy profile of the learners in a way that adheres to some type of predefined structures which could also be used to guide the curriculum design. From an institutional perspective, it is crucial the digital capability to be expressed not only qualitatively, defining the required skills and competencies, but also quantitatively, to enable its measurement and further development. For these reasons it was important to confirm the validity of the questionnaire tool and show that it could consistently quantify the digital capability of students and staff.

5.2 Intervention 3 (Action 8): Exploring the revised Digital Literacy Self-assessment Questionnaire $DigComp_{v1}$

In the previous research phase (Phase 1) it was observed that students and academic staff use technologies in their own individual ways to fulfil a variety of needs across the entire spectrum of their everyday lives (Evangelinos and Holley, 2014a, 2015a). Only in specific contexts, where transferable digital skills can be employed to solve problems or meet specific needs, does digital literacy have meaning. Thus the main drivers are the needs of the participant or technology-user. For example, one could prefer to use email for work but would rather use the telephone, or web conferencing for team meetings, and social media for communicating with friends or family. All these are examples of digital technologies used for communication but the digital skills and the depth of their mastery could vary considerably. This is because each individual has a profile of technological use that depends on a variety of priorities and individual preferences, fairly unique and individualised. For these reasons, the questions of the revised $DigComp_{v1}$ digital-literacy questionnaire tool were formed in such a way that could be considered as illustrative of a number of scenarios that the participants were more likely to be familiar with.

The analysis of this revised questionnaire tool, based on $DigComp_{v1}$, follows the same protocol as in the previous chapter and for this reason justification for the employed methods has been omitted for the sake of brevity. This had been made explicit when the analysis significantly departed from the previous approach in order not to be assumed as the same. The revised version of the digital-literacy self-assessment questionnaire has been formulated in two versions, one for the measuring of the digital literacies of the students [TOOL_02] and one for the academic staff [TOOL_03] after consultation with the institutional gatekeepers. Both versions of the questionnaire were structurally the same in terms of the digital-literacy areas, composition of the measurement scales, and response formats but, as the questions had been rephrased, it was decided the collected data sets not to be merged for the purpose of maintaining methodological purity. For this reason the exploration of performance of the questionnaire tool was based on the data collected from the academic staff since the sample size was larger ($n = 86$) in comparison to the student sample size for intervention 3 ($n = 24$) and for intervention 4 ($n = 36$). The consistency and validity of the revised self-assessment questionnaire was evaluated by issuing [ACTION_08] the staff version of the digital-literacy questionnaire [TOOL_03] to academic staff within the faculty.

5.2.1 The Revised Digital Literacy Scale and Response Format

The revised digital-literacy self-assessment questionnaire utilised an improved response format that was based on a scenario approach according to the DigComp$_{v1}$ structure. Participants were asked to self-reflect and state whether they believed they had the required digital skills to carry out the hypothetical technologically-enabled tasks and if they possessed the described knowledge and understanding in general. Specifically, they were asked to respond by selecting the examples that best matched or described their self-perceived skills. The questionnaire was constructed by taking the digital-skill examples proposed in the DigComp$_{v1}$ framework (Ferrari, 2013), and converting them into digital-competency scenarios that described the identified elements of digital capability.

The two versions differed only in the contextualisation of the hypothetical scenarios that had been aligned to potentially familiar situations. This new scenario-based approach was structured on the basis that each question, which represented an element of the higher-level competency area, presented the participants with examples of technology-use that were characteristic of the type and the level of the necessary digital capabilities according to the definition of this element in the framework. Participants were prompted to self-reflect on their skills by considering whether they could carry out the tasks that portrayed digital capability examples in a variety of contexts. The exact wording of the questionnaire prompt was:

'Please select the examples that ***best match your skills*** *from the hypothetical roleplay scenarios. You will need to consider the most appropriate answer according to your current skills as if you were to carry out the activities described in the examples that follow.'*

For example, a student participant would need to consider the following statements and choose the one best describing their competency. The complete questionnaire can be found in Appendix - TOOL_02 DL Questionnaire DigComp$_{v1}$ Student.

* 2. 1.1 Information - Browsing, searching and filtering information

- I can use a search engine to find details about a specific type of recycling waste.
- I can find a range of sources of information about a specific type of recycling waste by entering proper key words, and I can use a refined search to locate the most appropriate sources.
- I can find a range of sources of information about a specific type of recycling waste using different search engines and advanced searches, and I can also use online databases and searches through linked references.
- I don't have the skills to complete any of the above.

Figure 33 - DigComp$_{v1}$ Student Example Information: Browsing, searching and filtering information

The questionnaire was customised for staff by changing the scenarios so as to become more recognisable as examples suitable to academic and everyday-life tasks. The complete questionnaire can be found in Appendix - TOOL_03 DL Questionnaire DigComp$_{v1}$ Staff.

***3. 1.1 Information - Browsing, searching and filtering information**

- I can find details of flights using a common search engine.
- I can find details of flights using a number of search engines, and a number of airline company websites, selecting details that relate to scheduled times.
- I can find details of flights using a number of search engines, airline company web sites, and web sites that compare details of many airline companies, including costs and scheduled times.
- I don't have the skills to complete any of the above.

Figure 34 - DigComp$_{v1}$ Staff Example Information: Browsing, searching and filtering information

The individuals were expected to select the scenario they considered as most suitable to describe their skills. In the above examples a staff member could search for flights online and this was considered, from a technological-capability perspective, equivalent to students finding information on recycling waste. This tool is theorised to be more robust as it evaluates the self-professed skills and competencies by asking people to identify specific outcomes rather than make a more subjective evaluation of their perceived technological capabilities. Each statement was defined to reflect a certain level of digital-literacy competence that could be broadly interpreted as representative of the participants' experiences.

5.2.2 Sample

Members of the academic staff within the faculty were invited to complete the questionnaire on a voluntary basis, explicitly highlighting the fact that the data to be collected was to be used exclusively for research purposes and not to measure their performance. Informed consent was acquired electronically within the online survey system, on the basis of following a protocol for managing the data which guaranteed complete anonymity. It was achieved by anonymising the collected data from the outset by replacing the individual identifiers with a unique number that could only be tracked back to reveal an individual through the data gatekeeper. In addition, demographic information was not collected to exclude the risk an individual to be identified through it. Almost a third $(n = 86)$ of the academics within the faculty completed the questionnaire after three rounds of successive invitations corresponding to a participation rate of (32%). All questions pertinent to the digital-literacy measurement were compulsory to answer.

5.2.3 Validity

Examination of the validity of this new type of digital-literacy questionnaire was conducted along the same lines of the analysis carried out in phase 1. Statistical analysis was restricted by the type of the new response format and the data it produced. Specifically, the same statistical methods were applied to analyse the validity in terms of the instrument's characteristics as these arose from the participants' responses. Statistical analysis was carried out by utilising the Microsoft Excel 2013 spreadsheet software including the Real Statistics (release 4.12.1) plugin (Zaiontz, 2013a) aiming to evaluate the performance of the instrument with respect to the produced data seeking confirmation of its validity. The analysis that follows is also exploratory rather than confirmatory.

5.2.4 Normality

The data arising from the questionnaire were initially inspected for normality by examining the kurtosis and skewness values summarised in Table 26. For the information area (DLA1) we observe that the data recorded negative values for kurtosis and skewness, indicating a distribution that has lighter tails, a flatter than the normal peak, and it is skewed towards the left. The data for the communication area (DLA2) are platykurtic and skewed towards the right. Examination of the content-creation data (DLA3) indicates a leptokurtic, right skewed distribution. For the safety area (DLA4) the data demonstrate lighter tails and a flatter than the normal distribution peak, and are skewed towards the right. Finally, the data for the problem solving area (DLA5) showed a platykurtic distribution that was skewed towards the left. These findings are also confirmed through visual inspection of the symmetry for each digital-literacy area presented the Box Plots seen in Figure 35.

	DLA1	DLA2	DLA3	DLA4	DLA5
Mean	.6	.416	.339	.411	.393
Standard Error	.013	.017	.017	.015	.016
Median	.583	.417	.375	.375	.375
Mode	.667	.333	.375	.313	.375
Standard Deviation	.12	.153	.154	.138	.149
Sample Variance	.014	.023	.024	.019	.022
Kurtosis	-.447	-.428	.023	-.418	-.627
Skewness	-.526	.230	.169	.578	-.004
Range	.500	.708	.750	.625	.625
Maximum	.750	.750	.750	.750	.688
Minimum	.250	.042	0	.125	.063
IQR	.167	.250	.188	.188	.188

Table 26 - Questionnaire Analysis Digital Literacy Areas DigComp$_{v1}$ Descriptive Statistics

The descriptive statistics used to evaluate if the DigComp$_{v1}$ questionnaire data were normally distributed for each digital-literacy area.

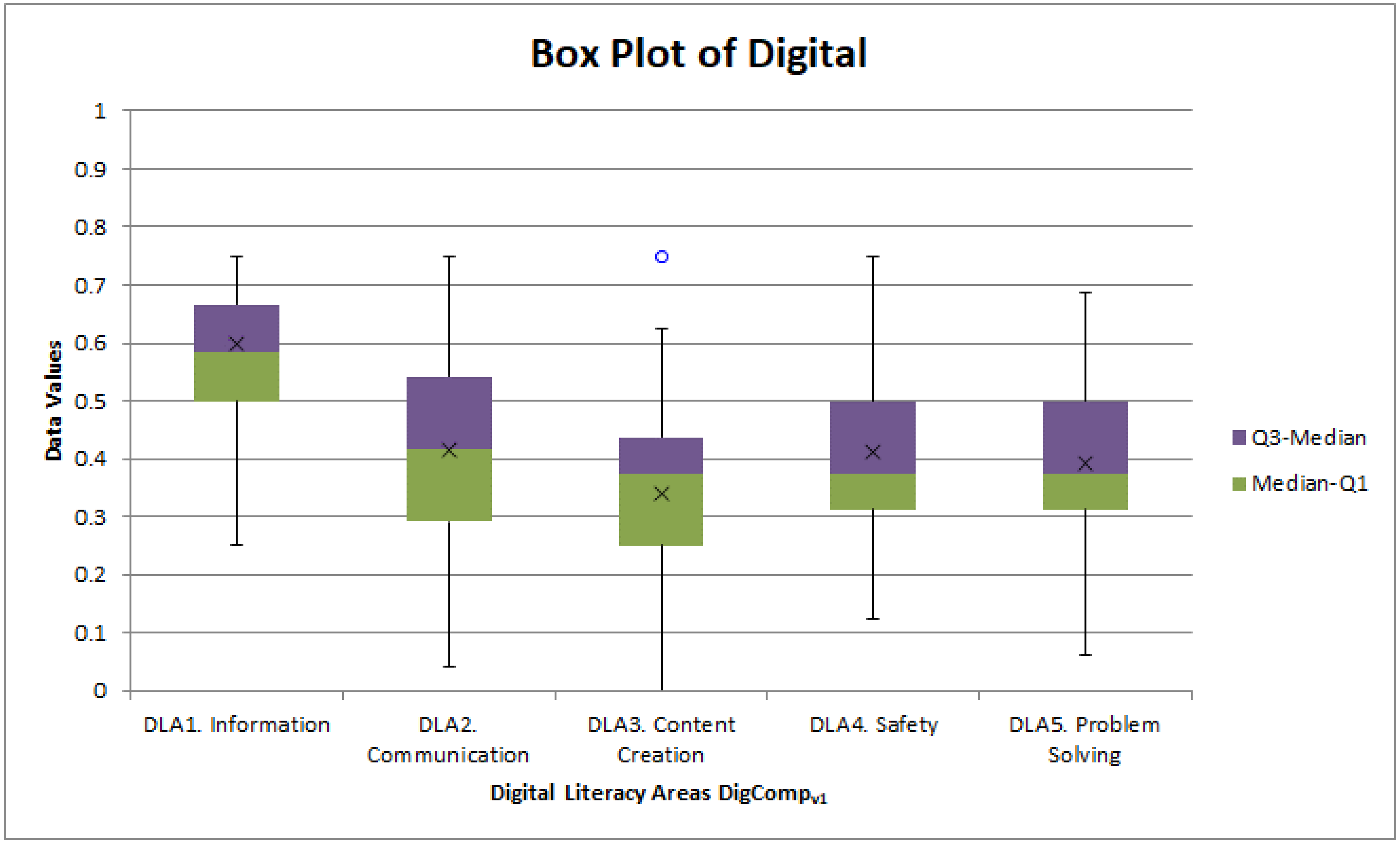


Figure 35 - Box Plots for the Digital Literacy Areas DigComp$_{v1}$

The Box plots illustrate the minimum/maximum value, the interquartile range (IQR) and the error bars for each DigComp$_{v0}$ digital literacy area. The outliers, where they exist, are depicted as circles.

In order to establish whether the results of the questionnaire tool [TOOL_03] based on the DigComp$_{v1}$ version of the framework corresponded to normality, the extended version of the Shapiro-Wilk's test for normality (Zaiontz, 2013b) was used. Similarly to the approach followed in the previous chapter, the W values were calculated for the mean values, after they had been normalised to unity for each digital-literacy area, with the results summarised in Table 27. Assuming that the null hypothesis H_0 requires that the sample comes from a normal distribution, and the alternative hypothesis H_a that the sample does not belong to a normal distribution, the null hypothesis is rejected if the p-value is less than the significance level.

At a significance level of $(a = 0.05)$ the data sets emerging from the responses of the participants for the digital-literacy areas of information and safety were not normally distributed, while the data for the areas of communication, content creation, and problem solving conformed to normality. It should be noted that the tests for normality were conducted in order to investigate the performance of the tool in relation to the data aiming to establish whether the tool could be used to quantify digital literacy and not to extrapolate any conclusions about the wider population.

	Information	Communication	Content Creation	Safety	Problem Solving
W	0.908492	0.972651	0.974867	0.935751	0.973305
p-value	0.000015	0.064696	0.091662	0.000343	0.071705
α	0.05	0.05	0.05	0.05	0.05
H_0	Reject	Fail to reject	Fail to reject	Reject	Fail to reject

Table 27 - Questionnaire Analysis DigComp$_{v1}$ Shapiro-Wilk's Test for Normality

The Shapiro-Wilk's test for normality applied to the data arising from the questionnaire tool that was based on the DigComp$_{v1}$ classifications. The results of the test confirmed that the data sets for the areas of information and safety were not normally distributed. Contrariwise, the data sets for communication, content creation and problem solving were found to be normally distributed.

5.2.5 Factor Analysis

Factor analysis utilising the principal axis extraction method was carried out to examine whether the theorised concept of digital literacy was the only significant underlying concept that was measured by the questionnaire tool. Confirmation of the existence of a single latent construct was also a prerequisite to subsequently employ Cronbach's alpha to investigate the internal consistency of the questionnaire as it manifested from the participants' responses. Employing the same protocol of examining the prerequisites for conducting factor analysis as before (intervention 2), the prerequisites of conducting FA were investigated.

The KMO-MSA values of all digital-literacy areas can be considered as meritorious according to Kaiser's (1974) scale and well above the lower acceptable value of 0.5 with an overall KMO value of (0.86) as it can be seen in Table 28. Multi-collinearity has been examined by searching to establish if the determinant ($\det R$) of the correlation matrix (R) is $\det R \neq 0$ signifying that the matrix is not singular. The determinant ($\det R$) of the correlation matrix (R) is $\det R = 0.0703$, which is > 0.00001, thus $\det R \neq 0$ the correlation matrix is invertible. The homogeneity of variance was examined by employing Brown and Forsythe's (1974) version of Levene's (1960) test with $H_0 = \sigma_1^2 = \sigma_2^2 = \cdots = \sigma_k^2$ and $H_a = \sigma_i^2 \neq \sigma_j^2$. The value of the test statistic is $F = 1.3451$ at $a = 0.05, p = 0.2523$. Since, the $p > a$ the null hypothesis cannot be rejected, it is concluded that there is insufficient evidence to claim that the variances are not equal. The results are summarised in Appendix - Digital Literacy Areas Spearman Correlation Coefficient $\text{DigComp}_{\text{v1}}$. Finally, the correlation values $\rho_{x,y}$ of the correlation matrix, presented in Table 29, are found to be within the acceptable range $0.90 > \rho_{x,y} > 0.30$ indicating that the variables are only moderately correlated.

Digital Literacy Areas DigComp$_{v1}$	KMO-MSA
DLA1. Information	.870
DLA2. Communication	.833
DLA3. Content Creation	.860
DLA4. Safety	.876
DLA5. Problem Solving	.889
Overall KMO	**.864**

Table 28 - The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) Questionnaire Data DigComp$_{v1}$

The Kaiser-Meyer-Olkin Measure of sampling adequacy (KMO) values for the DigComp$_{v1}$ digital-literacy areas. The KMO criterion was used to verify the adequacy of the samples (Kaiser and Rice, 1974).

Digital Literacy Areas DigComp$_{v1}$	1	2	3	4	5
DLA1. Information	1				
DLA2. Communication	.611	1			
DLA3. Content Creation	.493	.71	1		
DLA4. Safety	.427	.648	.66	1	
DLA5. Problem Solving	.497	.65	.656	.63	1

Table 29 - Correlation Matrix Questionnaire Data DigComp$_{v1}$

Examining the correlation matrix resulting from the DigComp$_{v1}$ questionnaire data the correlation values $\rho_{x,y}$ are found to be within the acceptable range $(0.90 > \rho_{x,y} > 0.30)$ indicating that the variables are only moderately correlated.

Having established that all the assumptions for conducting factor analysis were met, the principal axis method was used for conducting the factor extraction, aiming to find the smallest number of latent concepts that explain the variability of the associated digital-literacy areas. The Scree test was used to examine the contributions of the extracted factors based on the correlations of the digital-literacy areas and expressed as percentages of variance. Inspecting the graph in Figure 36 it is observed that the first factor accounts for the major value (92%) of the variance with the remaining factors having variances within the range of (0.39%) to (5.95%). According to the Scree test criterion (Cattell, 1966; Upton and Cook, 2008) the acute drop after the first factor suggests that there is only one concept that is described by the digital-literacy areas.

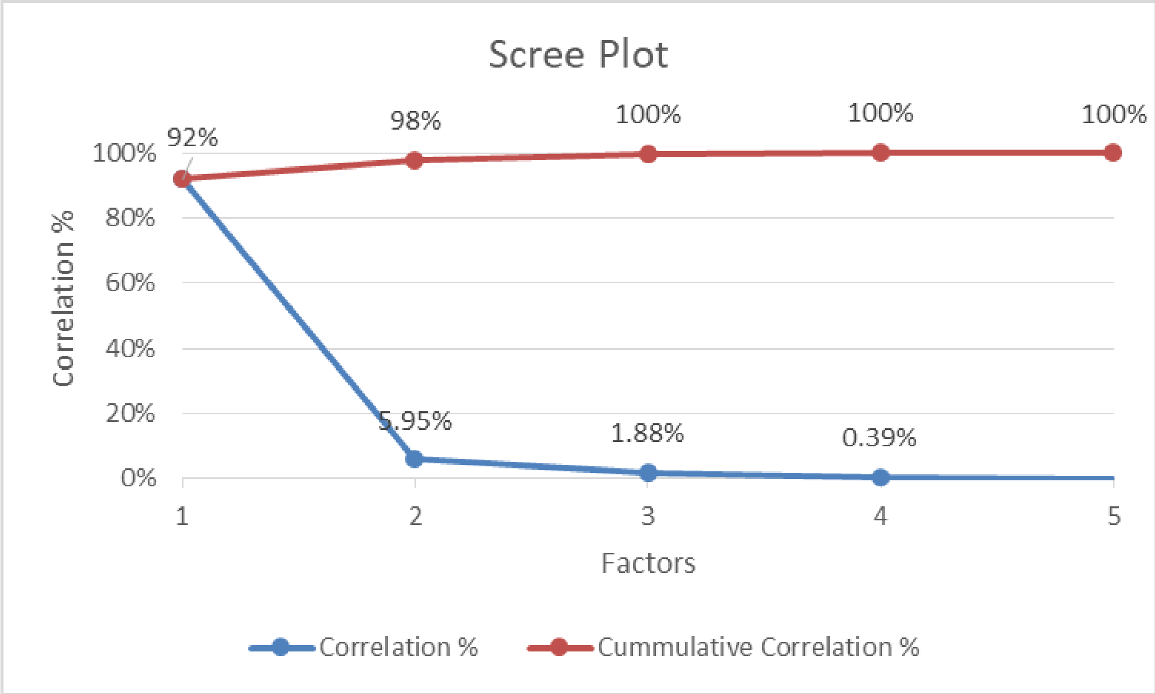


Figure 36 - Factor Analysis Correlation Scree Plot DigComp$_{v1}$

The correlation Scree plot for the factors arising from the questionnaire data DigComp$_{v1}$. The factors are illustrated on the x-axis where the correlation and cumulative correlation percentages on the y-axis.

Application of Kaiser's (1960) criterion to the Eigen values of the extracted components corroborates the conclusion arising from the Scree test as only the first component is over unity with a value of (3.41) while the rest were found to be significantly lower, ranging from (0.27) to (0.62). The complete Eigen-value and Eigen-vector matrix is summarised in Table 30. As it has been explained previously a factor is deemed to be significant if it loads > 0.5 exclusively on several variables (Guadagnoli and Velicer, 1988; Pett, Lackey and Sullivan, 2003) without significantly < 0.32 cross-loading on other variables (Osborne and Costello, 2009). Factors that are to be preserved should preferably load at a value of 0.7 representing a statistically significant contribution accounting for nearly half of the variance attributable to the factor for that variable (Beavers et al., 2013). In addition, a factor can be considered as reliable if it loads significantly from three to five variables which make sense conceptually (Osborne and Costello, 2009).

Examining the factor loadings presented in Table 31 it can be observed that there is only one factor resulting from the exploratory principal axis factor analysis which loads significantly to the variables and should be further considered. All five variables are loaded by the first factor with values ranging from (0.65) to (0.88) and there is no significant cross loading < 0.32 of any factor to other variables. Importantly all the loading values are greater than the ideal value of 0.7 with the exception of the value for the information digital-literacy area which is closely under, with a value of (0.65). As this value is well above the minimum acceptable threshold value of 0.5, it can be confidently concluded that there is only one latent construct, the theorised concept of digital literacy that has been identified from the responses of the participants.

Factors / Digital Literacy Areas	1	2	3	4	5
Eigen-values	***3.406***	***.619***	***.369***	***.340***	***.266***
DLA1. Information	.389	-.849	-.036	.225	-.274
DLA2. Communication	.478	-.101	-.235	-.284	.791
DLA3. Content Creation	.466	.224	-.176	-.643	-.537
DLA4. Safety	.444	.429	-.411	.664	-.097
DLA5. Problem Solving	.453	.186	.863	.117	.048

Table 30 - Eigen-values and Eigen-vectors DigComp$_{V1}$

Eigen-values and Eigen-vectors resulting from the Principal Axis Factor Analysis method on the data of the DigComp$_{V1}$ digital-literacy questionnaire.

Factors / Digital Literacy Areas	1	2	3	4	5
DLA1. Information	.647	-.304	.091	.008	-.035
DLA2. Communication	.878	-.179	-.139	.017	.035
DLA3. Content Creation	.825	.114	-.050	-.089	-.017
DLA4. Safety	.774	.227	-.045	.068	-.027
DLA5. Problem Solving	.791	.106	.176	.001	.034

Table 31 - Factor Analysis Full Load Matrix Questionnaire Data DigComp$_{V1}$

The full load matrix resulting from the principal axis factor analysis for the data arising from the DigComp$_{V1}$ digital-literacy questionnaire.

5.2.6 Internal Consistency

Cronbach's coefficient α was calculated across all digital literacy-areas to examine the consistency of the responses of the participants in respect to their digital literacy. This approach differs from the method employed in the previous chapter where the digital-literacy areas have been examined in isolation. The reason is that the questionnaire, based on $DigComp_{v0}$ [TOOL_01], was constituted by twelve digital-literacy areas with five questions each, amounting to a rather large number of sixty questions in total. In contrast, both versions of the revised questionnaire [TOOL_02] and [TOOL_03], based on $DigComp_{v1}$, were formed of twenty-one questions. These were grouped under the five digital-literacy framework areas, with three, six, four, four and four questions respectively, formulating each sub-scale. Because the magnitude of Cronbach's alpha has been shown to be dependent on the number of items under analysis (Gliem and Gliem, 2003) and the total number of items was not large, it was decided the internal consistency of the instrument to be evaluated by taking into account the complete scale that was comprised of all 21 questions.

This approach was considered to be methodologically acceptable as the results of the factor analysis have shown that there was only one concept measured by the questionnaire tool. It is important to note that within the boundaries of this research it was central to explore the $DigComp_{v1}$ framework taxonomy, as it was defined in its original form, rather than optimise the performance of the tools, with the purpose focused at investigating the performance of a tool that was strictly adhering to the classification areas and skills/attitudes examples of the framework. Acknowledging that further optimisation of the accuracy and sensitivity of these tools may be necessary, potential improvements, as well as discussion of the limitations of these tools in relation to their intended use and applicability, are discussed later in this thesis.

The overall Cronbach alpha ($\alpha_{tot} = 0.904$) was falling within the acceptable range $0.70 \leq a \leq 0.95$ and, as such, the scale could be considered as internally consistent (Terwee et al., 2007b; a; Mokkink et al., 2010). Following the same methodological approach as earlier in the analysis, the impact of the individual questions to the overall consistency was scrutinised by inspecting the alpha values after each question was removed in succession with the results summarised in Table 32. All questions, with the notable exception of question '1.1

Browsing, searching and filtering information', showed that they reinforce the overall consistency of the responses. In particular, questions '2.2 Sharing information and content' and '5.2 Identifying needs and technological responses' both contributed significantly to the overall consistency with ($a_{diff} = 0.008$). Conversely, question '1.1 Browsing, searching and filtering information' adversely affected the consistency by decreasing the overall alpha value with ($a_{diff} = -0.002$) and, although this performance aspect was noteworthy, it was not considered as significant since the consistency reduction was relatively small in comparison to the overall alpha value ($\alpha_{tot} = 0.904$).

Cronbach's Alpha Digital Literacy Areas												
a_{tot}	.904 at [95% CI 0.872, 0.931]											
Question removed	*Q1.1*	*Q1.2*	*Q1.3*	*Q2.1*	*Q2.2*	*Q2.3*	*Q2.4*	*Q2.5*	*Q2.6*			
$a_{(q-1)}$	.906	.904	.899	.897	.897	.899	.899	.901	.900			
$a_{diff} = a_{tot} - a_{(q-1)}$	**-.002**	.0003	.005	.008	.008	.005	.005	.003	.004			
i_{me}	.178	.183	.191	.196	.196	.192	.191	.188	.190			
Question removed	*Q3.1*	*Q3.2*	*Q3.3*	*Q3.4*	*Q4.1*	*Q4.2*	*Q4.3*	*Q4.4*	*Q5.1*	*Q5.2*	*Q5.3*	*Q5.4*
$a_{(q-1)}$	.898	.901	.901	.898	.899	.903	.901	.898	.898	.896	.899	.903
$a_{diff} = a_{tot} - a_{(q-1)}$	.006	.003	.004	.006	.006	.001	.004	.006	.006	.008	.005	.001
i_{me}	.194	.188	.189	.193	.192	.185	.189	.194	.193	.196	.192	.185

Table 32 - Digital Literacy Areas DigComp$_{v1}$ Overall Scale Analysis

The Cronbach alpha values for the DigComp$_{v1}$ digital-literacy scale after each question has been removed in succession. Question '1.1 Browsing, searching and filtering information' adversely affected the consistency of the scale by -0.002. All other questions increased the consistency with questions '2.2 Sharing information and content' and '5.2 Identifying needs and technological responses' contributing the most by 0.008.

In order to fully evaluate the questionnaire tool a parallel analysis was conducted at the sub-scale level as the research focus was exploratory, and consideration of the performance of the digital-literacy areas at the sub-scale level was deemed to be useful. Because of the small number of questions constituting each digital-literacy sub-scale, it was expected these not to be relatively consistent. Nevertheless, an exploration of how the sub-scales performed, after each question constituting them was removed, it was considered to be of value. This was particularly pertinent in the information digital-literacy area that was constituted of only three questions. The Cronbach's alpha values for each digital-literacy area (a_{ca}), the index of measurement error (i_{me}) and the 95% confidence intervals (CI_{LB}, CI_{UB}) were calculated for each digital-literacy area separately. Each question constituting the area under investigation was removed successively, the coefficient alpha was recalculated ($a_{(q-1)}$) and compared to the overall alpha (a_{diff}) of each area to explore the consistency of the responses and the impact of each question. The results are presented in Table 33.

Digital Literacy Areas Sub-scale Analysis						
1. Information						
$\boldsymbol{a_{ca}}$	.272 at 95% CI [0, 0.503]					
Question removed	*Q1.1*	*Q1.2*	*Q1.3*			
$\boldsymbol{a_{(q-1)}}$	.363	.000	.000			
$\boldsymbol{a_{diff} = a_{ca} - a_{(q-1)}}$	**-.091**	.272	.272			
$\boldsymbol{i_{me}}$	.868	1	1			
2. Communication						
$\boldsymbol{a_{ca}}$	.783 at 95% CI [0.703, 0.847]					
Question removed	*Q2.1*	*Q2.2*	*Q2.3*	*Q2.4*	*Q2.5*	*Q2.6*
$\boldsymbol{a_{(q-1)}}$	.713	.725	.756	.754	.786	.765
$\boldsymbol{a_{diff} = a_{ca} - a_{(q-1)}}$	.070	.059	.027	.030	**-.002**	.019
$\boldsymbol{i_{me}}$	.491	.475	.428	.432	.383	.415

3. Content creation						
$\boldsymbol{a_{ca}}$	.655 at 95% CI [0.518, 0.76]					
Question removed	*Q3.1*	*Q3.2*	*Q3.3*	*Q3.4*		
$\boldsymbol{a_{(q-1)}}$	.558	.574	.676	.527		
$\boldsymbol{a_{diff} = a_{ca} - a_{(q-1)}}$	.097	.081	-**.021**	.128		
$\boldsymbol{i_{me}}$	.689	.671	.543	.723		
4. Safety						
$\boldsymbol{a_{ca}}$	.674 at 95% CI [0.507, 0.755]					
Question removed	*Q4.1*	*Q4.2*	*Q4.3*	*Q4.4*		
$\boldsymbol{a_{(q-1)}}$	.592	.644	.627	.573		
$\boldsymbol{a_{diff} = a_{ca} - a_{(q-1)}}$	.082	.030	.047	.101		
$\boldsymbol{i_{me}}$	.650	.585	.607	.672		

5. Problem solving						
$\boldsymbol{a_{ca}}$	.714 at 95% CI [0.601, 0.801]					
Question removed	*Q5.1*	*Q5.2*	*Q5.3*	*Q5.4*		
$\boldsymbol{a_{(q-1)}}$	.625	.530	.660	.752		
$\boldsymbol{a_{diff} = a_{ca} - a_{(q-1)}}$	.090	.184	.054	-**.038**		
$\boldsymbol{i_{me}}$	.610	.719	.564	.434		

Table 33 - Questionnaire Analysis DigComp$_{v1}$ Cronbach's Alpha for each Digital Literacy Area Sub-scale

The Cronbach alpha values for the DigComp$_{v1}$ digital literacy sub-scales after each question, within the sub-scale, has been removed in succession. All questions contributed positively to the consistency of the sub-scales except questions '1.1 Browsing, searching and filtering information', '2.5 Netiquette', '3.3 Copyright and licences' and '5.4 Identification of digital-competence gaps' that affected negatively the consistency of the sub-scales by -0.091, and -0.002, -0.021 and -0.38 respectively. However, with the exception of questions 1.1 and 5.4 the impact was not so significant so as to merit a revision.

While examining the alpha values it was observed that the information digital-literacy area value was rather small with ($a_{ca} = 0.272$) and, as such, the responses within this area when examined in isolation could not be considered as consistent. When question '1.1 Browsing, searching and filtering information' was removed from the scale, the overall alpha value for the digital-literacy area increased by (33%) meaning that this question contributed negatively to the consistency of the scale with ($a_{diff} = -0.091$). On the contrary, when questions 1.2 and 1.3 were removed, the alpha values decreased to near zero which indicated that the relative consistency of the responses between these two questions contributed most to the consistency of the scale for this area. These results indicate that the use of the three questions formulating the sub-scale does not produce consistent results when examined in isolation. There are two main factors that have been identified as having an impact on the consistency of the information sub-scale. This is the only area constituted by only three questions and, for this reason a lower alpha value was expected. However, this does not fully account for such a low value. Inspecting the response data for question '1.1 Browsing, searching and filtering information' it is observed that all respondents had selected the statement that represented a facet of the highest competence level, articulated as 'I can find details of flights using a number of search engines, airline company web sites, and web sites that compare details of many airline companies, including costs and scheduled times'. A likely explanation for the participants' performance was the fact that the scenario, representing the highest level of competence, was not challenging enough. An alternative interpretation of the phenomenon was that the sample population was indeed very competent in browsing, searching and filtering information. These interpretations are reciprocal as the participants could be considered to be very proficient in managing information due to their professional capacity as academics. At the same time the $\text{DigComp}_{\text{v1}}$ competence framework had not been designed to reflect the digital capabilities of highly trained professionals. On the contrary it had been designed to be inclusive and define the digital competences required from the lay population.

In the area of communication the overall alpha value that was ($a_{ca} = 0.783$) indicated a good degree of internal consistency. Questions '2.1 Interacting through technologies' and '2.2 Sharing information and content' contributed the most to the consistency of the responses, increasing the alpha value by (8.97%) and (7.50%) respectively with ($a_{diff} = 0.07$) and ($a_{diff} = 0.059$). In contrast, question '2.5 Netiquette' negatively affected, although to a minor degree, the overall consistency by (0.28%) with ($a_{diff} = -0.002$).

Overall, the questions formulating the scale for this area performed well, producing consistent responses that were demonstrated by the alpha values falling within the acceptable range. The adverse effect of question '2.5 Netiquette' to the overall consistency was not considered significant enough to warrant any revisions because the overall alpha value was within the acceptable range.

The alpha value for the content creation digital-literacy area was ($a_{ca} = 0.655$). Question '3.4 Programming' influenced the consistency of the responses the most within the scale, with ($a_{diff} = 0.128$). At the other end of the spectrum, question '3.3 Copyright and licences' decreased the consistency of the responses within the with ($a_{diff} = -0.021$). The alpha value for this digital-literacy area was just under the lower bound of the acceptable range ($0.70 \leq a \leq 0.95$) and for this reason it was considered that minor revisions could have improved the consistency of the responses.

Similarly to content creation, the area of safety recorded an overall alpha value of ($a_{ca} = 0.674$) that was again narrowly under the lower bound of the acceptable range. Question '4.4 Protecting the environment' contributed the most to the overall consistency of the scale within this digital-literacy area with ($a_{diff} = 0.101$) followed by question '4.1 Protecting devices' with ($a_{diff} = 0.082$). The consistency of the responses, as it was measured by the alpha value, has shown that is falling outside the acceptable range but the alpha value was close enough to the lower bound and, for this reason, the consistency of the scale did not constitute a significant reason for concern.

An alpha value of ($a_{ca} = 0.714$) that was within the acceptable range was recorded for the area of Problem Solving. Question '5.2 Identifying needs and technological responses' positively influences the consistency of the responses within the scale with ($a_{diff} = 0.184$). Question '5.4 Identification of digital-competence gaps' reduced the consistency of the responses with ($a_{diff} = -0.038$). Although the decrease in consistency was noteworthy, it was decided that it did not constitute a sufficient reason for revising the scale, having considered the exploratory nature of this analysis and having taken into account that the overall alpha exceeded the lower bound of the acceptable range.

In summary, the sub-scale analysis showed that, with the exception of the information digital-literacy area, all other areas produced reasonably consistent results. This conclusion should be considered within the exploratory context of the sub-scale analysis and does not suggest that the sub-scales, when considered in isolation, are consistent from a confirmatory perspective. The consistency of the information digital-literacy area was severely affected by the small number of questions and the extreme ceiling effects of question '1.1 Browsing, searching and filtering information'. The DigComp_{v1} questionnaire tool is considered to be consistent but there is also evidence that it could be improved by authoring additional questions for the information area and revising the scenarios representing advanced competency.

5.2.7 Conclusion

In conclusion, so far as the internal consistency of the DigComp_{v1} questionnaire tool was concerned, when the sub-scales of the digital-literacy areas were unified, it was shown that the overall alpha of $(a_{tot} = 0.904)$ at [95% CI 0.872, 0.931] was close to the upper boundary of the acceptable range $(0.70 \leq a \leq 0.95)$ and for this reason it should be considered as consistent (Terwee et al., 2007b; a; Mokkink et al., 2010). The unification of the sub-scales to an overall scale could be justified by the results of the factor analysis showing that the questionnaire tool identified one latent concept which was theorised to be that of the digital literacy.

However, when the internal consistency of the sub-scales was examined, the results indicated that the areas of information, content creation and safety were not necessarily internally consistent, with alpha values of $(a_{ca} = 0.272)$, $(a_{ca} = 0.655)$ and $(a_{ca} = 0.674)$ respectively. The sub-scales for the areas of communication and problem solving were deemed to be within the acceptable range, with alpha values of $(a_{ca} = 0.783)$ and $(a_{ca} = 0.714)$ respectively. Gliem and Gliem (2003, p.87) quoting George and Mallery (2002) characterise alpha values between $0.6 < a < 0.7$ as questionable, which means that careful consideration of their practical interpretation is needed. The area of information was especially problematic as the alpha value was so low that even if a more tolerant limit was applied, it would still be deemed as not consistent. This was due to the extreme ceiling effects observed in one of the questions, and the small number of questions (three in total) that constituted the sub-scale of this digital-literacy area.

The investigation of the performance of the tool was limited by the relatively small numbers of participants, the lack of established digital-literacy assessment tools that could be used for statistical modelling and comparisons, the response format limitations and the self-enforced restriction of adhering to the DigComp framework structure. The sample size, although adequate for the conducted exploratory analysis, it was not sufficient to perform advanced statistical modelling and confirmatory analysis, especially as there were no previously established models or standards for measuring digital literacy that could be used for comparison. The response format, and the questions imposed by the self-enforced requirement of adhering to the DigComp framework taxonomies and exemplars of digital competences, skills and attitudes, was found to be limited in sensitivity and could not measure digital literacy at a more detailed resolution, especially towards the upper boundaries of the digital-literacy scale. This effect was particularly evident by the extreme ceiling effects observed in the information digital-literacy area.

Nevertheless, the analysis provided useful insights in the performance of the questionnaire by exploring the data that arose from the participants' responses. This revised version of the tool was more robust as it recorded the levels of self-professed skills in an objective manner, in contrast to the more subjective evaluation response format that had been used in the previous version. The questionnaire was considered to be intrinsically more robust as it evaluated the digital literacy of the participants based on the premises that the participants met the requirements of the tasks, and provided examples of knowledge corresponding to the relevant competence levels. This alternative type of response format could enable the questionnaire results to become repeatable and auditable, as it established objective criteria that were binary in nature (either met or not). Digital capability could be assessed by requiring the participants to demonstrate their digital competencies by completing the described tasks, and audit their general knowledge and attitudes. This improvement in the response format was important as it allowed the participants to self-assess their digital capabilities objectively, rather than subjectively.

In conclusion, a larger in-depth study will be needed to establish robustness and statistical power that will allow more comprehensive modelling. For this reason the results presented here and in the previous chapter should be interpreted as an exploratory pilot-study, and not as a robust confirmation of the validity of the tool when the research objective is to make inferences or comparisons in respect to the wider population. However, the questionnaire could be used to quantitatively evaluate the general level of digital literacy of individuals and groups, and produce a generic map of their digital-literacy characteristics. In the context of this research the questionnaire tools were used to establish the digital literacy of students and academic staff. This measurement could then be used to balance/optimise the requirements of the technology-enabled activities for the embedding of digital literacy in the curriculum, and of the digital capabilities of academics and students.

5.3 Intervention 4 (Actions 9 & 10): Investigating the Digital Literacy Needs of Healthcare Students when using Mobile Devices in the Classroom

The digital attitudes, skills, and development needs of healthcare students were evaluated when they used tablet devices in the classroom to facilitate digitally enabled learning. The student experience of a group of second-year midwifery students was evaluated when undertaking technology-enhanced learning activities delivered through a combination of pre-classroom study and in-classroom activities using mobile devices.

5.3.1 Methods

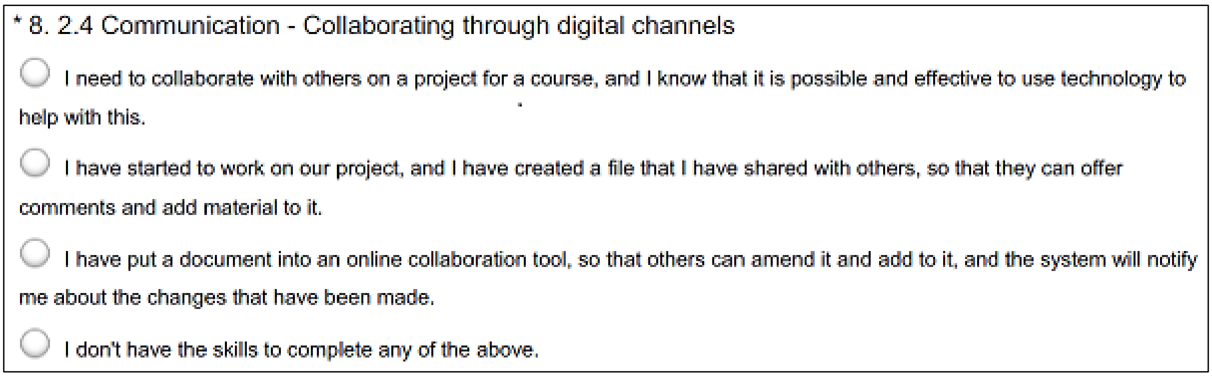
The chosen module for the intervention was taught by a number of tutors under the co-ordination of the module leader in two different campuses. In order to maintain parity of the student experience, the two student groups, formed according to the geographical location of their studies, were given the same information and were subjected to the same research protocol. Similarly to intervention 2 the activities were designed to deliver disciplinary learning outcomes and, at the same time, to incorporate a variety of digital skills as these had been defined by the $\text{DigComp}_{\text{v1}}$ framework. Following the established research and ethical protocols, the participants $(n = 36)$ were asked to complete [ACTION_09] the student version of the self-assessment questionnaire [TOOL_02] that was based on $\text{DigComp}_{\text{v1}}$. A short electronic questionnaire [TOOL_04] issued in the classroom was used to evaluate [ACTION_10] their experiences $(n = 56)$ when undertaking these technology-enhanced learning activities. Students were asked to indicate their agreement on a four-step agreement/disagreement scale that also included the option of not wanting to answer. The statements were the following:

1. I enjoy working collaboratively
2. I learn better by engaging in activity-based learning
3. I feel that I have the digital skills required to complete the activities
4. I need more support in using technologies
5. I would like to have more opportunities to learn collaboratively and participate in activity-based, technology-enhanced learning

The research was conducted ethically according to the research protocol as it was explained earlier in this thesis. It must be noted that, although participation in the learning activities was compulsory as it was an integral part of the module, it was made clear to the students that participating in the research and answering the two research questionnaires was optional. Initially there were thirty-six respondents to the digital-literacy self-assessment questionnaire, but one student decided to withdraw, and after contacting the data gatekeeper their contributions were removed from the dataset as it was stipulated in the ethical protocol. Thus the sample size was reduced to thirty-five participants.

5.3.2 Benchmarking the Digital Literacy Potential of Students using the Self-assessment Questionnaire DigComp$_{v1}$

The questionnaire [TOOL_02] required the participants to self-assess their digital literacy by selecting the most appropriate scenario to their perceived skill-set. Students were asked to think whether they possessed the skills and attitudes to complete the proposed activities regardless of having actually completed similar activities in the past. The questionnaire presented the participants with five groups of questions corresponding to the digital-literacy areas of the DigComp$_{v1}$ framework. These questions, formulated as technology-use scenarios, were customised to present the students with authentic situations relevant to their experiences. An example of the scenario-based questions can be seen in Figure 37. The questionnaire also included a simplified demographic section concerning the participants' gender and age, two additional questions on how they find out about new technologies, and if they have used a number of pre-selected technologies for formal/informal learning, research, work, and/or in their personal lives.


* 8. 2.4 Communication - Collaborating through digital channels

- I need to collaborate with others on a project for a course, and I know that it is possible and effective to use technology to help with this.
- I have started to work on our project, and I have created a file that I have shared with others, so that they can offer comments and add material to it.
- I have put a document into an online collaboration tool, so that others can amend it and add to it, and the system will notify me about the changes that have been made.
- I don't have the skills to complete any of the above.

Figure 37 - Question 2.4 of the Self-assessment Questionnaire DigComp$_{v1}$

The results were exported and analysed by using the Microsoft Excel 2013 spreadsheet software including the Real Statistics (release 4.12.1) plugin (Zaiontz, 2013a) to reveal a wealth of quantitative indicators for the student digital capabilities and behaviours. Similarly to the staff digital-literacy questionnaire discussed in a previous section of this thesis, each digital-literacy area was quantified by scales constituted of different numbers of scenarios. For example, the information-area index derived from the average value of three information-literacy questions. The communication and content-creation areas were expressed as the average of six questions each, while safety and problem solving were represented by the average of four questions each.

5.3.2.1 Results

The results of the 21 questions organised in the five areas of the framework are summarised in Figure 38. These were measured on a scale from 0-3 where a value of 0 indicates no skills, (>0 and <=1) denotes basic competency, (>1 and <=2) intermediate and (>2 and <=3) is considered as advanced. For example, the index value for information literacy showed a mean value of (2.30) denoting that, on average, students have an advanced self-declared competency in the information digital-literacy area. The group was least confident about their self-declared skills in the content-creation area with a mean of (1.64), denoting intermediate competence. The mean values for each digital-literacy area can be used to baseline the general group competency and give a single value index of the group's digital-literacy potential. This approach resulted in an overall measurement for digital literacy but, as it over-simplified a complex picture, it was of limited use. The frequency distribution gives a more nuanced perspective on the numbers of individuals at each competency level across the digital-literacy areas. As it can be observed in Figure 39, the digital capability of the individuals across the different areas of digital literacy within the groups is variable.

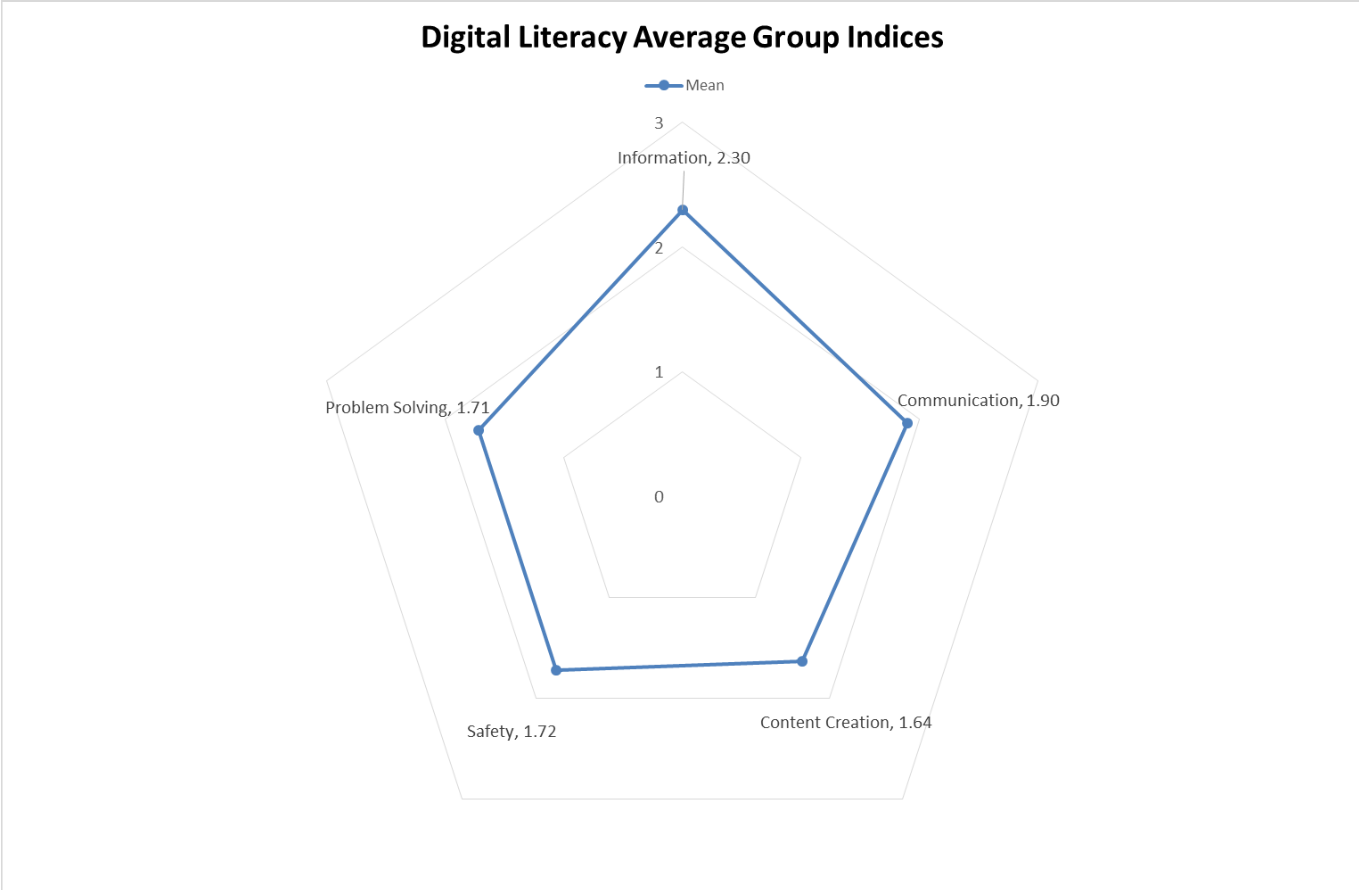


Figure 38 - Digital Literacy Average Group Indices (Intervention 4)

The average (mean) group indices for each DigComp$_{V1}$ digital-literacy area. These were measured on a scale from 0-3 where a value of 0 indicates no skills, (>0 and <=1) denotes basic competency, (>1 and <=2) intermediate and (>2 and <=3) is considered as advanced. The group self-assessed as advanced in the digital literacy area of Information with a competence index value of (2.3) with all other areas been classified as intermediate.

On average, the groups' information and communication digital capabilities were well-developed. In the information-literacy area the vast majority (92%) self-reported intermediate competency or above, with a significant proportion (60%) reporting advanced. In the communication digital-literacy area (94%) reported intermediate or above, with (37%) of them being advanced. Students felt reasonably confident in the problem-solving technological skills with (80%) reporting intermediate competency or above, with (29%) being advanced. The lowest performing areas were those of content creation, with (77%) reporting intermediate competency or above, and only (20%) advanced. In the area of safety (74%) reported intermediate competency or above with (31%) classified as advanced.

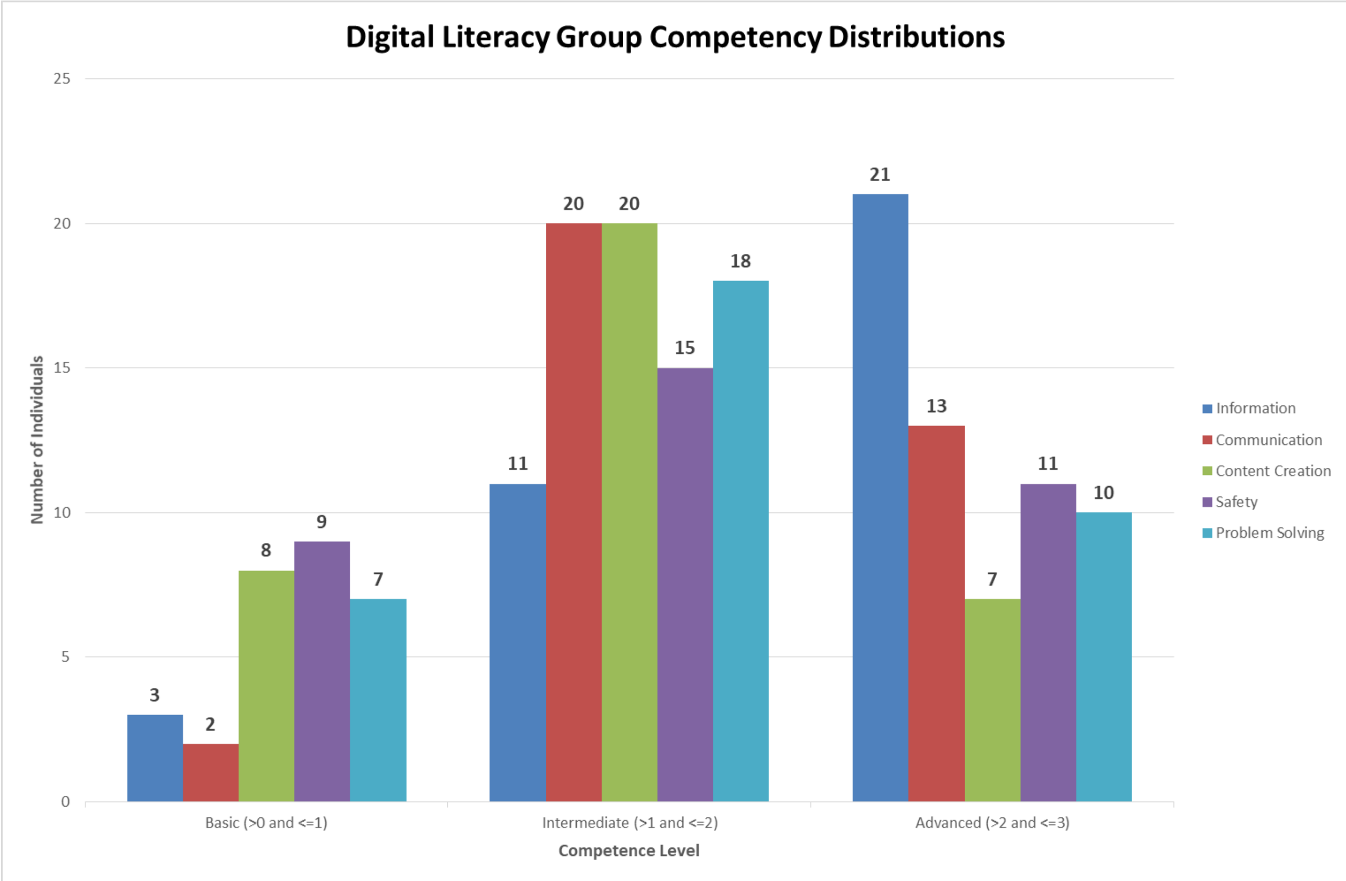


Figure 39 - Digital Literacy Group Competency Distributions (Intervention 4)

The group distributions for each DigComp$_{v1}$ digital literacy area derived from the number of individuals. These were measured on a scale from 0-3 where a value of 0 indicates no skills, (>0 and <=1) denotes basic competency, (>1 and <=2) intermediate and (>2 and <=3) is considered as advanced. The data shows the distributions of the participants with basic, intermediate and advanced digital competency for each digital literacy area. This type of analysis is useful when detail is needed on the exact numbers of individuals, for example, when considering the targeting of training or personalisation of digitally-enhanced learning activities.

When students were asked how they find out about new digital technologies, they reported that they discover new technologies primarily from friends and family (80%), online digital sources (43%), traditional media (40%), as part of their course at university (29%), library services (6%), as part of their CPD at work (6%), and professional or other specialist network (6%). Participants were also asked to identify their preferences on using selected technologies and report on their use in their private, academic and work lives. Figure 40 summarises how students utilise the different types of technologies for formal/informal learning, research, work and in their personal lives.

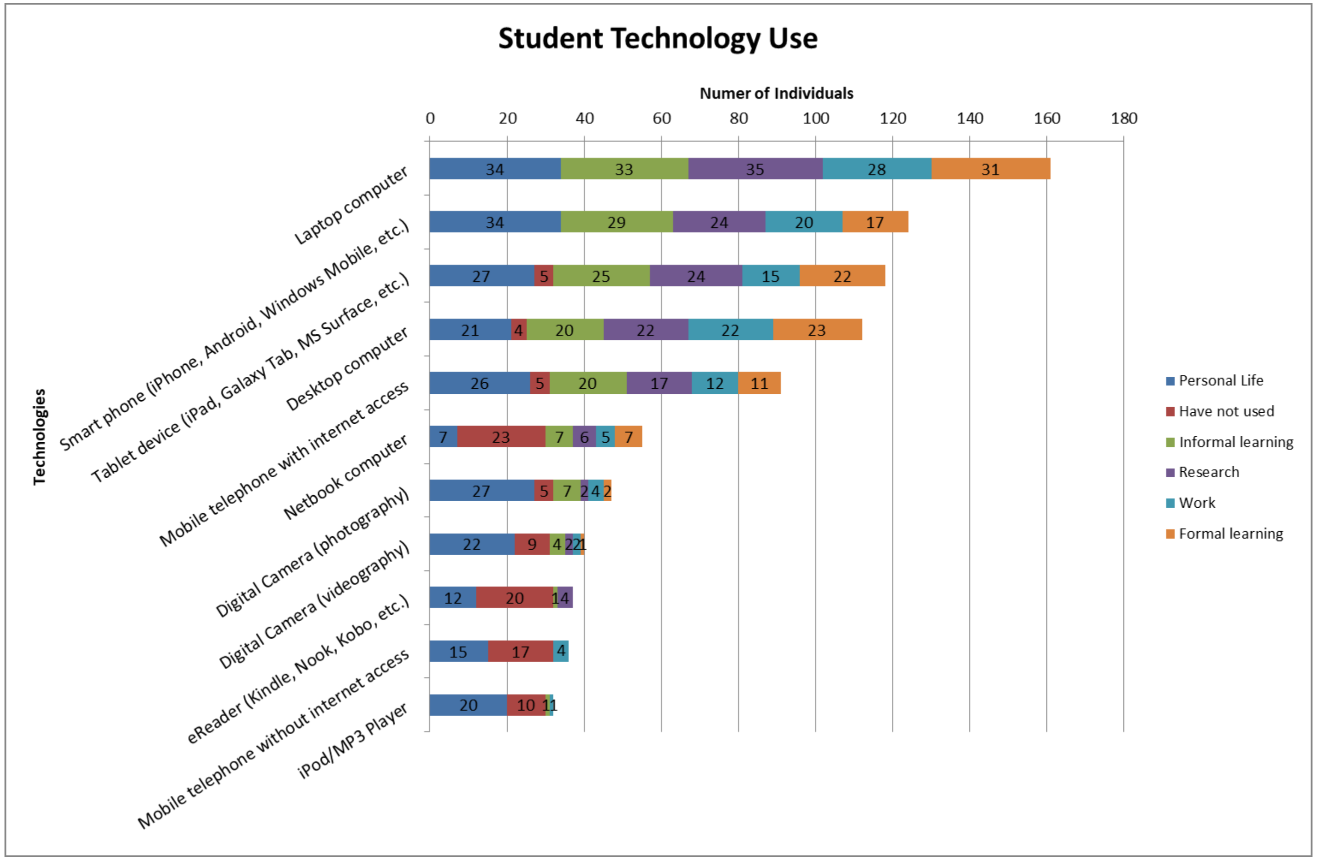


Figure 40 - Student Technology Use Pattern (Intervention 4)

The student technology-use patterns broken down by technology use in formal learning, informal learning, research, personal life, work and no use. This information is useful when evaluating the types of technologies that students use also demonstrating the types of usage. Note that the participants were allowed to select technologies for multiple uses.

From a technology-use perspective, students self-reported significant use of technologies in their private, academic and work lives. Specifically, laptop computers were the predominant technology used in formal learning with desktop computers, tablets and smartphones also commonly used. A similar profile of technology use was observed in informal learning where again laptop computers were the most prevalent technology, followed by desktop computers and mobile technologies. Laptops are the most utilised devices in research while smartphones, tablet devices and desktops are also used regularly. In the workplace laptops and desktops were used by the majority of the respondents with mobile technologies used by a significant minority. In their private lives, students seemed to use a larger variety of technologies. The use of mobile technologies and laptops was prevalent but digital cameras for photography and videography were also used. However, it is interesting to note that a significant minority of students have never used netbook computers, e-book readers, mp3 players, digital cameras, tablet devices, desktop computers or mobile telephones without internet access.

The three most used devices for formal learning were laptops, desktops and tablets while for informal learning these were laptops, smart phones and tablets. When conducting research, the three most used devices were laptops, tablets and smart phones. This indicates a trend for increased use of mobile devices and for the use of tablets and smartphones for learning. It is also noteworthy that desktop computers are only prevalent in the formal learning scenario. This is likely to be happening because they are institutionally provided in the formal academic environments and many students do not own desktop computers at home. The top three devices used in the private lives of the students were smart phones, laptops and tablets. The data suggests that the types of technologies they use are changing and moving away from the traditional desktop computer towards mobile technologies, such as smart phones, laptops and tablet devices. For this reason, academic institutions should modernise their digital-device provision to include and support mobile devices, be prepared to utilise mobile technologies for learning and teaching, provide appropriate material for the use of these devices, and acknowledge that these technologies are increasingly used by the students for formal/informal learning and research in general.

5.3.3 The Classroom-based Learning Designs

Once the digital capabilities of the group had been benchmarked, the students were asked to undertake a number of learning activities. The learning designs utilised in this intervention were co-designed with the module leader and involved three sessions that were delivered twice, once in each geographical location. The incentive for changing the mode of curriculum delivery was mainly due to changes in the formal assessment specifications and to the realisation that thoughtfully designed, digitally-enhanced activities could improve the students' digital skills. For these reasons, the design team decided that parts of the curriculum, previously classed as self-directed learning, could be delivered more effectively as blended experiences within the classroom, utilising a semi-flipped teaching model.

Two half-day workshops were conducted for this purpose. In the initial session the team established the objectives, format and an outline of the content. In the second they reviewed and quality-assured the delivery structure and the content of the activities. The design sessions were led by the Module Leader, who had the overall responsibility for the module, in collaboration with the Learning Technologist who provided technological-pedagogical expertise, having a secondary role, as the researcher. Following the same approach as previously, the activities were designed to deliver elements of the disciplinary learning outcomes and develop the digital skills of the students. The designs included ten activities delivered over three sessions, and were documented by Learning Design maps that were created by using CompendiumLD (The Open University, 2011). The activities illustrated in Table 34 have been mapped against the digital-literacy areas of the DigComp$_{v1}$ framework.

Activity / Digital Literacy Areas	Information	Communication	Content Creation	Safety	Problem Solving
S1.A1 Pre-work narrated PowerPoint	✓				
S1.A2 Check understanding of resources via facilitated discussion		✓			
S1.A3 Group work on pros and cons on local vs distant communities		✓	✓		✓
S1.A4 Individual work on deciding on the community of choice	✓				✓
S2.A1 Pre-work reviewing the resources	✓				✓
S2.A2 In groups students put together 3 slides		✓	✓		
S2.A3 Pecha Kucha student presentations		✓			
S3.A1 Pre-work reviewing the resources	✓				✓
S3.A2 Students individually read a paper and identify the answers to a workflow diagram	✓				✓
S3.A3 Produce a 300 words narrative based on the elements identified previously and share with the group		✓	✓		

Table 34 - Classroom Learning Activities Mapped on the Digital Literacy Areas of the DigComp$_{v1}$

The classroom-based learning activities were mapped on the digital-literacy areas of the DigComp$_{v1}$ framework. The prefix in the name of each activity indicates the session and activity numbers. For example, S1.A1 denotes session 1, activity 1.

Unlike the approach used previously in designing the online learning activities, a method that was flexible and allowed for a variety of designs, the face-to-face, classroom-based designs were restricted in terms of logistical parameters. For this reason factors such as timing, class size, availability of technology, network infrastructure, and digital capability of students and academic staff had to be carefully considered before the design could commence. This does not mean that these parameters have strictly dictated the choice of pedagogies and associated digital tools, but that they had to be determined and considered so as to ensure a realistic design which would meet the curriculum requirements, and could practically be implemented with the allocated resources, without requiring substantial additional support.

The digital component of the activities was delivered through a combination of institutional technologies and the utilisation of cloud-based services, such as Google Documents and Google Drive. The selection of the technologies used was determined by the availability of the institutionally-supported technologies and the logistics for ensuring that a sufficient number of digital devices were made available to students who might not own such devices. A pool of institutionally-owned tablets was made available to ensure that every student had access to a digital device to carry out the activities, although students had been encouraged to use their own if they wished. In practice, about half of the students decided to use their own devices and this significantly simplified the logistics for facilitating the technology-enhanced activities.

The learning designs followed the same approach as before. The activities had been documented in a linear fashion from top to bottom, indicating the timeline of events and the learning objectives, tasks, actors and technologies, and had been recorded graphically alongside a simple representation of their interactions. This approach documented in sufficient detail the activities without being too convoluted and complicated to interpret. The learning designs were used as a description of the activities at an abstracted level and did not aim at providing a detailed step-by-step guide on how the activities should be conducted. The complete set of designs can be found in Appendix - Learning Designs. For example the learning design for the first session can be seen in Figure 41.

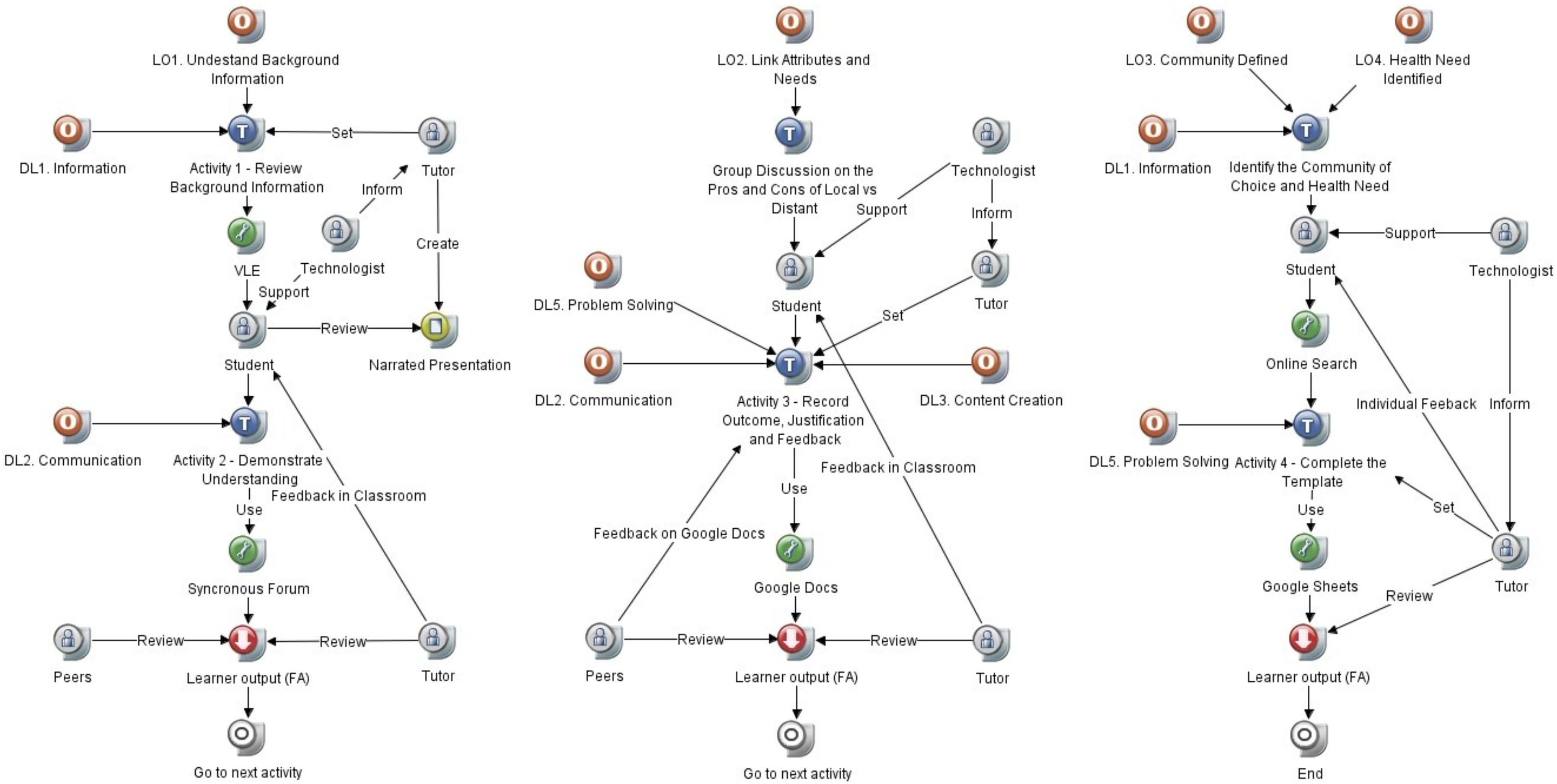


Figure 41 - Session 01: Community Profiling (Activities 1-4)

The Community Profiling session constituted of five learning activities, four of which required engaging with technologies. The disciplinary learning outcomes were identified alongside the digital-literacy skills that were to be developed by undertaking these technologically-enabled tasks. The outcomes were linked to the tasks, the technologies were identified, and the primary actors had been associated with the teaching assets so as to form a concrete structure. The diagrams had an embedded workflow where the top to bottom structure identified the sequence of the events. The first learning activity (Activity 1) required the students to review a narrated presentation that had been prepared by the tutor on the VLE to ensure that they had reviewed the background information. Then the students proceeded with making comments on a synchronous discussion forum (Activity 2) in the classroom by using a variety of technologies including laptops, smartphones, and privately-owned or institutionally-provided tablet devices. The students reviewed each other's posts and the tutor provided summary feedback orally in the classroom.

The tutor facilitated further exploration of the information through face-to-face discussion in the classroom, ensuring that relevant ideas and approaches were deliberated and that the students had understood the task and the required outputs correctly. The students proceeded in recording their outcomes individually and making justifications on a shared Google Document page (Activity 3), as well as peer-reviewing of each other's work by making constructive critical commentary on their peers' contributions. The tutor reviewed the quality of contributions and gave oral feedback to the group in the classroom to assure the quality of the contributions and reinforce learning. The task that followed required the students to identify their topic of choice by conducting further online search while in the classroom.

Finally, the students had to complete a Google Sheet template (Activity 4) with information relevant to their topic of choice, so as to ensure that by the end of the session they would have made an evidence-based decision on the task. The tutor reviewed the plans shortly after the end of the session, and provided individual feedback. The learning technologist informed the tutor on how to create the learning assets and technology tasks, and supported the students throughout the session according to their technological needs. The student-postings formulated the evidence for formative assessment tasks and remained available for the students to review for the duration of their module.

Two further sessions were designed and delivered in similar terms as part of this curriculum intervention. The students by the end of each session were given opportunities to raise their concerns and request further technological support. In a small number of occasions they approached the technologist with some issues concerning the transfer and archiving of data and the troubleshooting of a variety of other issues with using their own devices. Providing that level of support was particularly important as there was widespread demand from the students to be able to use their own devices for conducting the activities in the subsequent sessions.

5.3.3.1 The Student Experience

The student experience of those undertaking the digitally-enabled activities contained within the three sessions delivered in the classroom as part of Intervention 4 was explored by a short questionnaire. The questionnaire included five questions aiming to evaluate the student experience of undertaking technology-enhanced, activity-based learning by using devices in the classroom. The participants ($n = 56$) indicated their agreement or disagreement on a four-step scale that ranged from strongly agree, agree, disagree and strongly disagree with a discreet option of not answering. The results can be seen in Figure 42.

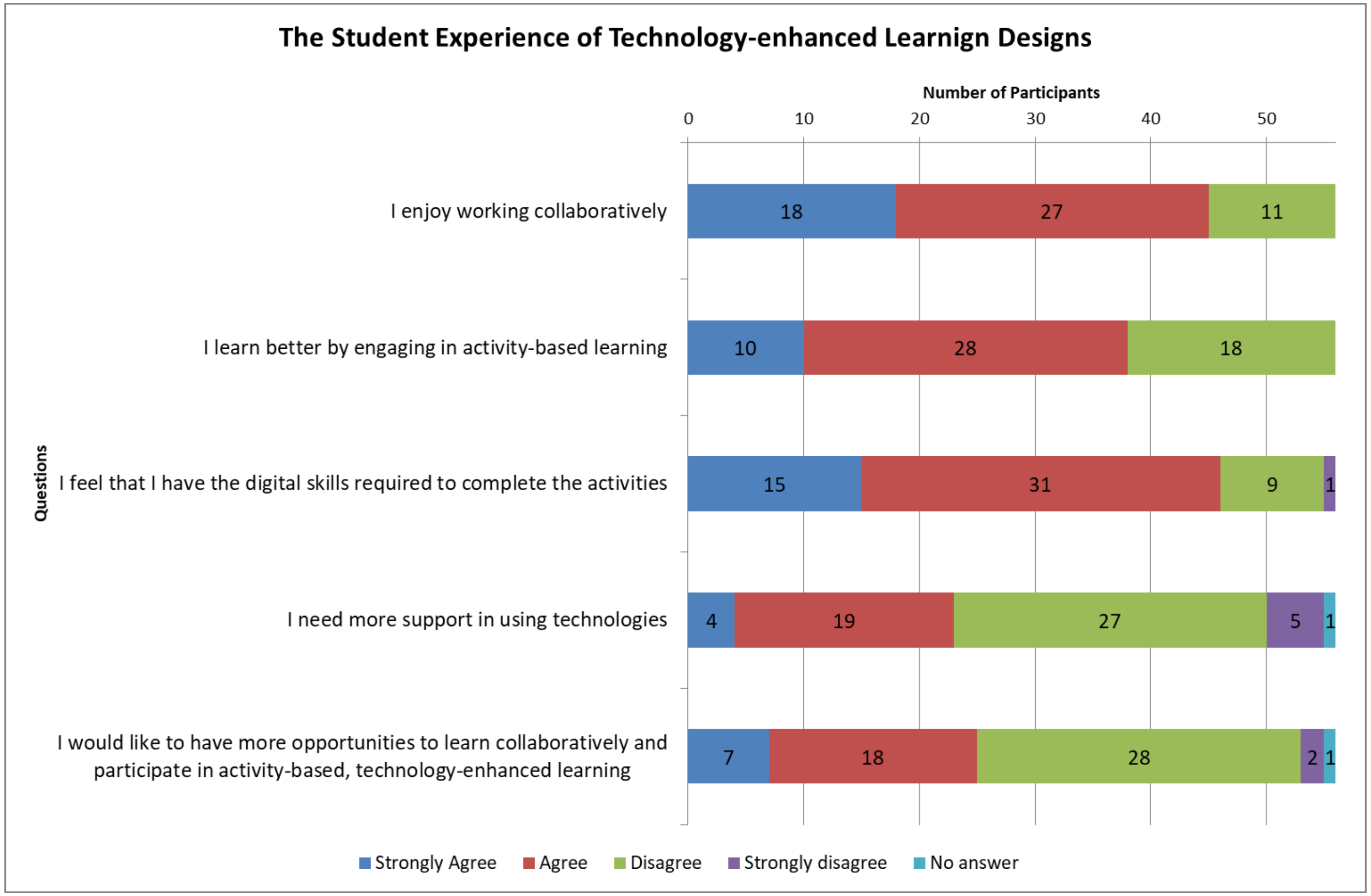


Figure 42 - The Student Experience of the Classroom-based Technology-enhanced Learning Designs

The results of the student experience survey for the classroom-based technology-enhanced learning designs. A four-step scale was used that ranged from strongly agree, agree, disagree and strongly disagree with a discreet option of not answering.

The vast majority of students stated that they enjoy working collaboratively while a considerable majority reported that they learn better when engaging in activity-based learning. Most students felt confident they possessed the digital skills required to complete the given activities. More than half of the participants said that they do not require any additional support in using technologies, but a significant minority stated that they would benefit from additional support. Finally, on the question of whether they would like more opportunities to learn collaboratively and participate in technology-enhanced, activity-based learning, more than half said that they would not, but a sizeable minority said that they would. Overall, students seemed to be enjoying learning together, found the activities beneficial for their learning and felt confident about their digital skills. The group seemed to be split on whether they would need more technology-support and whether they would appreciate to be given more opportunities for this type of technology-enhanced learning. A possible explanation for this contradicting behaviour could be the fact that some of the participants felt intimidated and uncomfortable when using new, unfamiliar technologies for the first time.

5.3.4 Conclusion

The case studies presented in this research phase (Phase 2) documented the utilisation of tablet devices in the assessment of student-nurse clinical competences in practice (intervention 3) and when used for activity-based learning in the classroom for the utilisation of technology-enhanced learning designs (intervention 4). In both case-studies a snap-shot of the digital-capability potential of the participants was established by issuing the bespoke self-assessment questionnaire. The questionnaire toolkit was based on the EU DigComp$_{v1}$ framework and produced quantitative, metric data corresponding to the digital competences, skills and attitudes of the participants. Following a multi-method approach, additional qualitative data was gathered and the student experience was documented.

Students seemed to be reasonably competent in using technologies to communicate, learn, and research, and they generally use them in a variety of ways. As individuals they showed on average a command of digital competence above-intermediate. At the same time the group seemed less comfortable in the areas of content creation, safety and problem solving, and more competent in information management and communication. Although at the individual level there is significant variance of digital capability, it must be stressed that the purpose of this intervention was the consideration of group dynamics as a broad-brush approach for the optimisation of teaching. This type of analysis is of interest when considering the development of digital skills and competences in learning and teaching. The frequency distribution of the participants' digital competencies could reveal clusters (or sub-groups) of students with similar digital-capability potentials. Individuals can be categorised to sub-groups who lack digital skills and others who present expert profiles. This method of analysis offers possibilities for early identification of students with advanced, or indeed, lacking in, essential digital skills. In the latter case this categorisation offers potential for early intervention in the classroom and for further development and utilisation of those already possessing advanced skills.

The student experience of utilising tablet devices to perform learning tasks in the classroom and beyond was evaluated. This part of the research employed a process for embedding digital literacies into curriculum-delivery by utilising activity-based, technology-enhanced learning designs. The majority of students enjoyed working collaboratively and recognised that they learn better when engaging in activity-based learning. Most of them felt comfortable because their level of digital skills was sufficient to complete the activities. Over half of the students thought that they did not require any further support in using digital technologies, but a significant minority thought otherwise. Finally, on the question whether they would like to have more opportunities to learn collaboratively and participate in activity-based, technology-enhanced learning, just over the half replied negatively, with a sizeable minority replying positively.

In summary, the metrics offered an assessment of digital literacy which combined with an analysis of technology-use and the student experience helped to build a more complete picture of the participants' digital capabilities and their preferred digital devices used within private, workplace and academic contexts of learning.

5.4 Overall Conclusions and Next Steps

In phase two of the research, the framework definitions were updated according to the $DigComp_{v1}$ structures, the response format of the self-assessment tool was improved and the student experience re-evaluated (Intervention 3) by adhering to the methodological approach applied in phase one, in order to maintain a basis for comparison. The results reinforced the previous findings showing that the revised framework and the associated metrics that arose from the improved self-assessment tool could be used to embed digital literacy in the learning activities (Evangelinos and Holley, 2015b). The analysis of the student experience indicated that these activities should be offered as a combination of formal/informal, authentic learning opportunities within a workplace, or an academic context. Similarly to the results of the previous phase, the importance of establishing a quantifiable approach to digital literacy was highlighted in relation to establishing the digital-capability profiles of students and staff, as well as framework structures and classifications that could be used to evaluate the digital requirements of an activity, or a learning design. This phase of the research was completed by applying flexibly the same learning-design approach for the creation of digitally-mediated learning-activities and for the evaluation of the student experience when delivered in the classroom through utilisation of mobile devices (Intervention 4).

The results of the student-experience evaluation (Evangelinos and Holley, 2016a) substantiated those previously obtained (Evangelinos and Holley, 2016b). The revised self-assessment tool with the improved response format was shown to be internally consistent and highly-reliable. However, although promising, the results deemed to be inclusive due to the relatively small sample-size for this type of statistical analysis. The updated $DigComp_{v1}$ framework was found to be a robust basis for describing and quantifying digital literacy and, as such, appropriate to inform the design of learning activities that embed digital literacy in the curriculum in a variety of learning situations. Reflecting on the results of this enhancement phase (Phase 2) that broadly corroborated with the findings of the initial exploratory phase (Phase1), and focusing on enhancing local practice, it was considered pertinent to formalise the processes and tools developed for embedding digital literacy in the curriculum. The following chapter documents the concluding phase of the research (Phase 3) that proposes a holistic curriculum-design approach supported by models, processes and tools that facilitate the development of digital literacies as an intrinsic by-product of a learning activity. The models and processes were informed by a critical evaluation of the relevant literature in relation to the data and the findings of the localised approach reported so far in this thesis.

Chapter 6. Phase 3 – Model and Operationalise

Drawing from current theories and following a critical review of the work presented in this thesis, this chapter proposes an approach for developing the digital literacies of students and staff in the context of a higher education learning environment. Evidence supports that digital capability is developed more efficiently when the digital skills are embedded in the curriculum and contextualised within a discipline (Leeds Metropolitan University, 2011; Thomson et al., 2014). The assumption that people learn in a variety of ways and that learning can be designed in terms of guided educational activities is at the core of this approach (Tergan, 1997; Gholson and Craig, 2006). Digital skills are acquired when engaging with digital technologies to carry out specific tasks. Learning itself happens within and for the individual, and it is unique in many ways due to the individual's subjective nature of interpretation of his environment that results from their experiences (Bandura, 1986, 1989; Lau, 2001). Based on these principles, a pragmatic approach that utilises models, tools and processes for the development of digital literacy comes as a by-product of technology-enhanced, activity-based learning designs.

6.1 Towards a Holistic Curriculum Development Approach

In the previous chapters of this thesis the challenges of developing digital literacy within the context of local practice were explored. In particular, phase 1 investigated how a digital-literacy framework can be used to support student learning in the local healthcare settings (research question 1). The conducted case-study work investigated ways through which a framework approach can assist the understanding of how digital literacies manifest in student learning experiences and how they can be further developed (research question 2). This early exploratory and innovative stage guided the refinement and improvement of the approach which was further investigated through its application into a wider variety of learning circumstances in phase 2 (research question 2). The overarching aim of this research work was to conceptualise an operational process and create the necessary tools for embedding digital literacy in a variety of learning scenarios in local practice (research question 3). A summary of how the previously presented work informed the approach follows.

The research commenced by creating a self-assessment questionnaire [TOOL_01] based on the initial results of the DigComp$_{v0}$ framework (Janssen et al., 2013) that was used as a research instrument for conducting the semi-structured interviews [ACTION_01] that validated the framework and quantified [ACTION_02] the digital-literacy characteristics of the participants. The results showed that the questionnaire could be used to baseline the general level of digital literacy of individuals and groups and visualise their digital competence characteristics (Evangelinos and Holley, 2014b). The interview data from academics, students and academic-related professionals indicated that the participants demonstrated highly individualised digital-competence characteristics and behaviours as identified by the analysis of the results of intervention 1 (Evangelinos and Holley, 2014a). These results formed the evidence basis for validating the framework and were subsequently revised [ACTION_05] to reflect the DigComp$_{v1}$ revised taxonomy (Ferrari, 2013) at a later time (Evangelinos and Holley, 2015a).

An exploration of the applicability of the framework in embedding digital literacy into the curriculum [ACTIONS_03 & 4] followed by establishing a framework approach to inform the learning designs (Evangelinos and Holley, 2015b). The investigation showed that the framework could guide curriculum development when designing technology-enhanced learning activities. During intervention 3 the digital-literacy self-assessment questionnaire was also updated to reflect the structure of the $DigComp_{v1}$ framework and utilise a new scenario-based approach in an attempt to improve its reliability. This decision was taken because the results of intervention 2 showed that the questionnaire, which was based on an agreement/disagreement response format, could not be relied upon to produce repeatable results. Moreover, the large number of digital-literacy areas resulted in a rather long questionnaire that was challenging to complete. During the time it took to carry out the research the $DigComp_{v1}$ revised version was published promising to address some of the concerns. The updated questionnaire was used [ACTION_06] alongside [ACTION_07] a survey of the student experience. Considering these findings as to how these could be used to address research question Q.1.1 in particular, and identify rience on using digital technologies, to assess the students' digital literacy when using tablet devices for the assessment of their clinical competences in clinical practice (Evangelinos and Holley, 2016a). A staff-specific version of the questionnaire was also developed [ACTION_08] along the same lines, as it was acknowledged that developing the digital literacy of staff was of strategic importance for developing the digital literacies of students (Finlay and Nicholls, 2013; Garcia, Dungay, Elbeltagi and Gilmour, 2013; Gourlay and Oliver, 2013; Kerrigan et al., 2013b; Velden and Anagnostopoulou, 2013). The customised staff-specific questionnaire was administered to academic staff merged with additional questions for the assessment of their professional digital practices which aimed at investigating the potentials and limitations of measuring their digital capabilities.

This exploratory research approach was evaluated by the results of the two case studies (presented in chapters 4 and 5) that documented the student experience of undertaking technology-enhanced learning activities online (Evangelinos and Holley, 2015b), and when using mobile devices in the classroom (Evangelinos and Holley, 2016b). The first case study (intervention 2) assessed the student experience when undertaking learning activities, which were designed according to the classifications of the $DigComp_{v0}$ framework, to deliver parts of the curriculum content in a technologically-enabled way for the enhancement of their digital capabilities. The activities were delivered to the students by setting-up online study activities on a Virtual Learning Environment (VLE). The student experience was evaluated by asking the learners to keep short reflective diaries on the development of their digital capabilities when completing the activities. Students found the activities stimulating, meaningful and useful for their learning. Reflection on the results, summarised in chapter 4, revealed that the model could be further improved by constructing the curriculum content and the digitally-enabled activities in a flexible way that would allow for personalisation, so as to maximise the learning benefits for all students regardless of their starting competence point.

The second case study (intervention 4) documented the student experience when undertaking a similar set of technologically-enabled learning activities in the classroom through the utilisation of mobile devices. The digital component of the learning activities had been modelled according to the $\text{DigComp}_{\text{v1}}$ framework classifications and the student experience was evaluated through their answers on a short questionnaire. Comparing and contrasting the results of this case study to the previously conducted work reinforced the aforementioned findings, with the majority of the participants reporting that they enjoyed working collaboratively, benefited from engaging in activity-based learning and felt that they possessed the required digital skills to complete the activities. However, a significant minority reported the need to further develop their skills in using digital technologies. In general, participants acknowledged that technology-enabled, activity-based learning has been beneficial for their personal and professional development.

Having explored the appropriateness of the EU Digital Literacy $\text{DigComp}_{\text{v1}}$ framework to describe and measure the digital capabilities of students and staff, and having utilised an activity-based learning design approach to embed digital literacy in learning opportunities, it became apparent that a more formal approach had to be established in order to facilitate the wider implementation into practice. In response to this requirement models, processes and tools were created to enhance the curriculum-development process. The timeline of these events and the developed tools are illustrated in Figure 43.

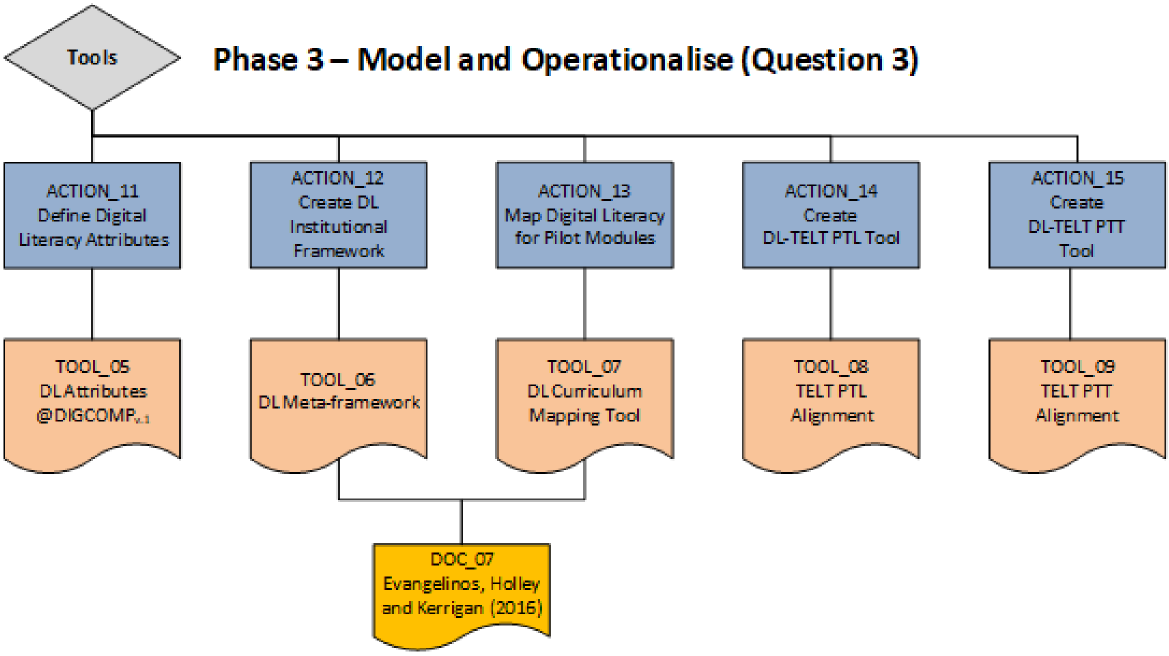


Figure 43 - Phase 3 Research Design

The Phase 3 research design illustrating the timeline for the development of the implementation processes/tools and the small pilot project.

A preliminary version of a digital-literacy framework [TOOL_05] defining the digital-literacy attributes required by the students [ACTION_11], based on the DigComp$_{v1}$ taxonomy (Ferrari, 2013), was formulated. After consultation with the key stakeholders across the institution these initial conceptualisations were revised [ACTION_12] to create a bespoke digital-literacy badging framework [TOOL_12] for institutional use. This revised meta-framework drew from the EU Digital Competence DigComp$_{v1}$ framework (Ferrari, 2013) and the Jisc-funded project Digital Literacy in Transition (Kerrigan et al., 2013a). A digital-literacy curriculum-mapping tool [TOOL_07] was created in support of the implementation process to map the existing digital-literacy characteristics of programmes of study (Kerrigan and Evangelinos, 2015).

It was observed that in practice teachers benefit from the structure and facilitation of the process of designing curricula (Mishra and Koehler, 2006; Conole and Weller, 2008; Mor, Craft and Hernández-Leo, 2013; Mirriahi, Alonzo and Fox, 2015). Davis and Krajcik (2005, p.1) explored the use of '*educative curriculum material*' through a disciplined design approach that acts as a learning opportunity for the teachers through development of learning resources. Stabback (2016, p.34) in his reflections on designing quality curricula explicitly states that '*Teachers need accordingly relevant advice ... adapting the curriculum to meet all learners' needs*'. Therefore, structure and support, when designing learning opportunities, are not only necessary but also beneficial as they develop the teachers' design capabilities and ensure the quality of the curriculum. For these reasons, two additional instruments have been created to facilitate the curriculum-development process. These were a curriculum tool to align pedagogies to teaching methods and assessment [TOOL_08] and a tool [TOOL_09] that facilitates the alignment of pedagogies to teaching methods and technologies. Both implement best practices arising from the work of Beetham and Sharpe (2013) on pedagogies and the Anglia Ruskin University Technology Enhanced Learning and Teaching (TELT) online tool (Anglia Ruskin University, 2016b).

The implementation approach suggested in this thesis draws elements from the theories and results of a number of studies that established best practices and, in particular, from a set of twelve case studies conducted by a number of UK educational institutions under the national Developing Digital Literacies programme (Joint Information Systems Committee, 2013). Furthermore, it relates to the work of White and Le Cornu (2010, 2017) and of Laurillard et al. (2013) exploring the concepts of personalisation, learning communities, and game-theory whereby learners have exhibited a variety of preferences of technology use across personal and institutional domains when working alone, or within a physical or virtual community. The approach was also informed by the work of Conole and Weller (2008) on design approaches for open educational resources (OER), in particular from the work of Galley (2011) on learning-design application and more generally from the wider work on the learning-design theory and practice of the OULDI project at the OU (Cross, Galley, Brasher and Weller, 2012a). Conole's (2014) 7Cs framework had a meaningful impact on this research which was drawn upon elements of the wider conceptualisations and in particular on the notion that Learning Design can be used as a framework to facilitate pedagogic development. Finally, this approach recognises the important relationship of staff and student digital literacy as noted by Walker and Kerrigan (2016) and how this links to curriculum development.

6.2 Embedding Digital Literacy in the Curriculum: Models, Processes and Tools

A structured, curriculum development process is proposed to embed digital literacy in the curriculum. It introduces research-informed bespoke tools to define digital literacy, facilitate curriculum design, and model appropriate staff development. This process (Model 1) operates alongside the established academic practices whereby learning outcomes are explicitly defined at course, module and task levels, and are constructively aligned. Initially at the curriculum-design stage the teaching activity is documented by a design perspective (e.g. defined course, module and task outcomes, abstracted learning designs and lesson plans) and is aligned to teaching strategies and assessment. Subsequently, at the learning-design stage, the content, learning activities and tasks, are constructively aligned to the curriculum requirements and metrics. The overall curriculum-design model [TOOL_11] can be seen in Figure 44.

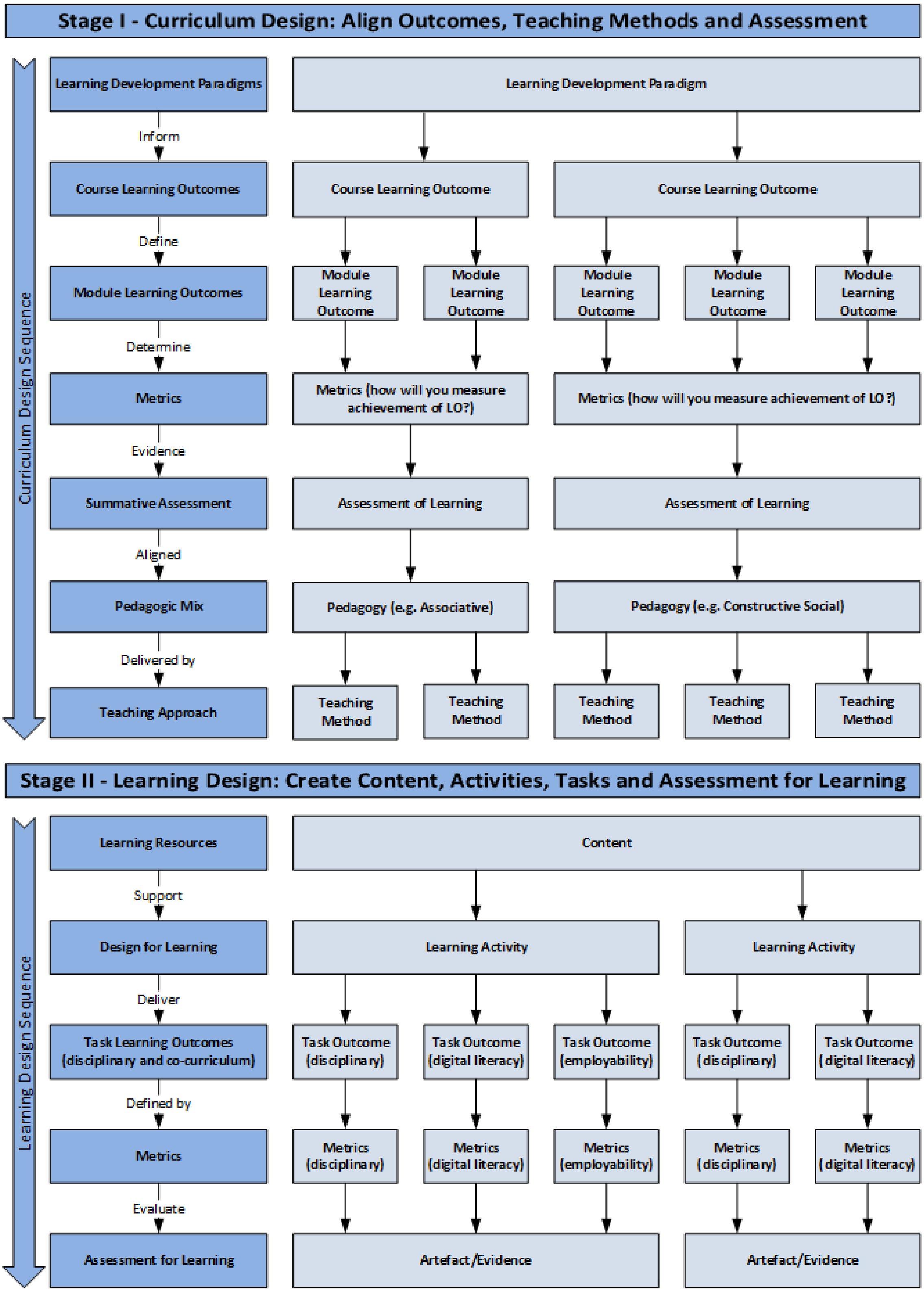


Figure 44 - Curriculum Design Model (Model 1)

Model 1 illustrates the process of curriculum development where the teaching activity is documented by **a design perspective (e.g. defined course, module and task outcomes, lesson plans, and activity designs) and is aligned to teaching strategies and assessment.**

Establishing a common understanding on how the developmental outcomes should be expressed in practice will guide the approaches to teaching. Consideration of potential pedagogies and teaching methods facilitates the translation of the learning outcomes to activities. Consequently tasks can be identified according to disciplinary and other developmental taxonomies (e.g. entrepreneurship, employability, sustainability) including digital literacy. It is assumed that all interactions of the learner with the curriculum will be identified explicitly to the required level of detail. Thus the approach identifies the features of the curriculum that formulate the evidence-basis for attainment in a way that can be recorded and analysed. The associated tool [TOOL_08] offers a description of potential teaching methods (or creation of learning opportunities) that are aligned to pedagogies summarising the benefits of the teaching approaches and providing examples of the types of assessment suitable for each method. Once the disciplinary outcomes, assessment, metrics and teaching approaches have been constructively aligned, digital-literacy task outcomes and metrics can be (re-)aligned in relation to the requirements of the curriculum [TOOL_12]. At this point the teaching methods should also be reviewed with respect to appropriate pedagogies and Technology Enhanced Learning and Teaching (TELT), and assessment technologies [TOOL_09]. A procedural algorithm that describes Model 1 [TOOL_10] is illustrated in Figure 45. The various stages of this procedural curriculum-development model are illustrated in Figure 46.

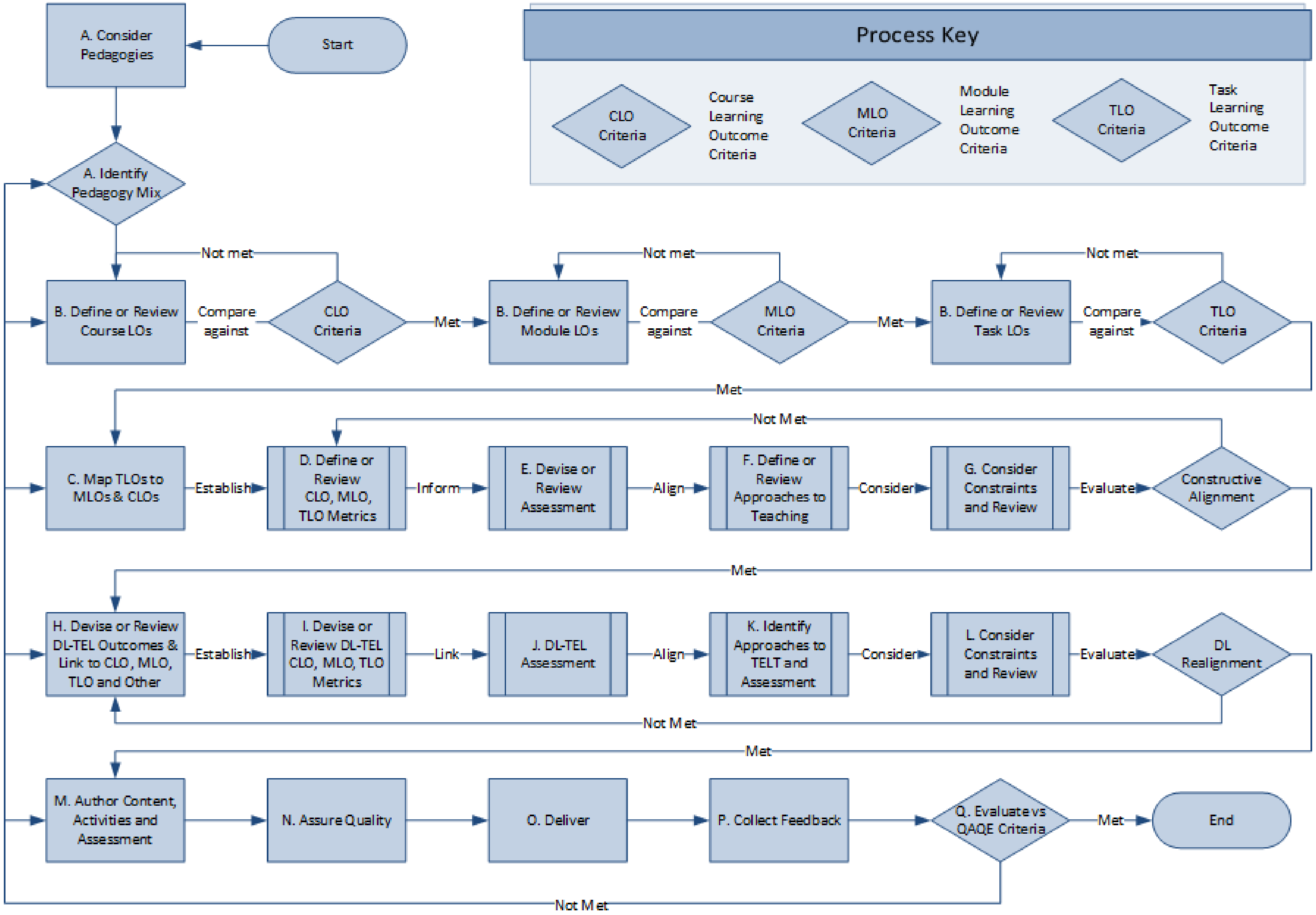


Figure 45 - Procedural Model for Embedding Digital Literacy in the Curriculum (Model 2)

The Stages of the Procedural Curriculum Development Model (Model 2)

A. The process commences with considering the pedagogies and/or identifying the existing pedagogic mix.
B. The course, module and task outcomes are considered in relation to the criteria and the pedagogic mix.
C. The interrelations of the course, module and task outcomes are identified and mapped.
D. Course, module and task metrics are established (these could be nested).
E. Assessment is aligned to the task, module and course outcomes/metrics and pedagogy.
F. The teaching approach is identified in relation to pedagogy and assessment.
G. Consider constraints (e.g. resources, student numbers, PSRB requirements).
H. Digital literacy task outcomes are devised and linked to course, module, task and any other outcomes (e.g. disciplinary, employability, sustainability).
I. Devise course, module and task metrics.
J. Digital literacy assessment is defined.
K. Technology mediated approaches to teaching and assessment are considered in relation to pedagogy
L. Consider the constraints (e.g. digital capabilities, technological availability, PSRB requirements).
M. Develop the content, activities and assessments.
N. Content, activities and assessment is quality assured.
O. Deliver the content, activities and assessments, and facilitate teaching.
P. Feedback is collected.
Q. Evaluate delivery against established quality criteria.

Figure 46 - The Stages of the Procedural Curriculum Development Model (Model 2)

Model 2 demonstrates the procedural model for embedding digital literacy in the curriculum. The model is based on Biggs' (1996, 2004) constructive alignment theory. Digital literacy is embedded in the curriculum by conducting a second order re-alignment and by introducing the concept of 'multi-variate' learning designs. These are defined as activities (or compound tasks) that deliver multiple outcomes simultaneously and are measured in their respective domains by key metrics. The various stages of development are summarised.

When this process is applied into practice a curriculum map can be created to show the interrelations of task outcomes, assessed or otherwise grouped into module outcomes, which in turn are grouped into course outcomes. Conole (2010a) suggested that the explicit identification of the links among learning outcomes is the good design of practice. Masterman and Craft (2013) explored this concept further in the context of a learning-design software. However, this needs to be done carefully in a way that it does not restrict creativity (Masterman and Manton, 2011; Laurillard et al., 2013). Biggs (1996) supports that the constructive alignment dictates the need of association of these learning outcomes with relevant teaching/learning activities and assessment. Hence, task, module and course outcomes can be measured by defining outcome metrics and evaluating the learner's progress through assessment tasks. Building on this constructive alignment approach it is proposed that further re-alignment can be applied at the design stage to embed a multitude of skills and competencies, such as digital literacy, in the curriculum. Following this re-alignment process through the curriculum and learning design stages, multi-variate activities (or compound tasks) that correspond simultaneously to the module and course learning outcomes can be designed, as well as other developmental taxonomies (e.g. digital literacy, employability, sustainability) and performance can be measured in a nuanced and immediate way, in multiple domains. An important pre-requisite for this method is the curriculum domains to be expressed in the form of clearly-defined developmental frameworks as it is easier to implement outcome-based curricula which are flexible enough to accommodate a variety of approaches. It should be noted that this pedagogical-development process is intrinsically linked, through the alignment process, to the delivery of teaching and assessment in support of the learners' journey of development. The model will operate best if a form of micro-assessment is employed whereby tasks are evaluated through formative/summative assessments and/or peer reviewed, and progress is recorded at regular intervals.

At an operational level it is proposed that this design-based method is implemented as a part of the formal institutional curriculum (re)-development process that is governed and quality assured (Anglia Ruskin University, 2016a). This is particularly important for the successful implementation as there are significant resource implications in documenting the curriculum in detail. Nevertheless, the resource requirements will decay over time as previous designs and material are re-used. This curriculum design and management process will be efficient, in the long term, as learning/teaching units can be shared across courses and enable flexible and innovative modes of delivery. The structured design approach will enable the sharing of curriculum resources as the elements will be constructively aligned and all the necessary meta-information needed for reusing resources can be collected at the design stage. These benefits will be realised when the curriculum is documented, at an abstract level, in a way that maps the interrelations of the various outcomes, and identifies the desired developmental competencies and metrics. The delivery methods (taught or self-directed), learning activities and assessment tasks should be documented through learning designs, alongside the content and resources which should also be identified and aligned explicitly. The digital-delivery platform will capture, in a structured way, all relevant details about the learning activities, as these data can be used to extrapolate the manifested features of the curriculum and define the domains of learner development. For example, the data can be used to analyse how learners engage with the curriculum elements, their performance on the tasks and, in general, to document their learning development in multiple domains. These data could also be used to inform and enhance future curriculum designs, or identify areas for improvement with regard to the performance of the students undertaking the curriculum activities. Depending on the level of granularity this design approach can also enable the personalisation of learning.

At an institutional level, application of the proposed model will enable the formulation of a curriculum-management system, which will enable the monitoring of student engagement and attainment by documenting teaching activity while at the same time will be recording the manifested evidence of learning in the form of a variety of assessed or peer-reviewed outputs. Arguably this ideal approach must be considered within the realities of an operational institution and with respect to the existing IT infrastructure, the established institutional cultural norms, and local practices. Recording the curriculum in such detail is a challenging task as it necessitates the involvement of all academic staff in defining what the curriculum elements are at a specified level of detail, and provide a record of the teaching activity. Nevertheless, the benefits of improving the curriculum quality-assurance processes and the monitoring of student engagement and progress are significant. Therefore, it is proposed that all teaching activity should be documented and mediated to an appropriate degree within the institutional Technology Enhanced Learning (TEL) systems in an organised way that will allow the data to be tracked and analysed.

6.2.1 The Theoretical Underpinnings of the Approach

Considering the pedagogical principles and directions, the precept that technology should be seen as an enabler of learning and, in cases, as a topic for learning is embraced. However, this proposed design-approach does not mandate a specific pedagogical basis to explain how people learn with technologies (Mayes and de Freitas, 2013). Biggs' (1996) constructive alignment is at the core of models 1 and 2 whereby teaching methods and assessment tasks are aligned to outcomes. Subsequently, a second order alignment (digital re-alignment) takes place whereby the defined outcomes are examined in an organised way, in respect to digital activity, so as to ensure that they enhance digital capability while meeting the other curriculum requirements. Depending on the context, technological capability could overlap in various degrees the disciplinary outcomes, as certain tasks need to be mediated by technology. Alternatively, if this is not possible or desired, additional outcomes can be authored alongside the disciplinary outcomes to meet the digital-literacy developmental needs. By careful design of the activities, teaching/learning methods and use of technology it is possible a learning activity to deliver a combination of digital and subject-based outcomes simultaneously. A key assumption of the approach is that the development of digital literacy of students and staff can be facilitated by designing and embedding digitally-enabled learning opportunities within the curriculum (Leeds Metropolitan University, 2011; Thomson et al., 2014). The pedagogical principles are central to the curriculum development and determine the ways through which learning is facilitated by the act of teaching. At the same time digital literacy is postulated to be an expression of the cognitive capabilities in the digital domain with the aim at achieving explicit outputs. Since technological capabilities are also perceived as topics of study intrinsic to curriculum activities, digitally-mediated learning opportunities or events can be designed to direct these activities and enhance digital capability. These learning designs can direct the learner's engagement with technology and play the role of the Vygotskian Mediating Artefacts (Vygotsky, 1962, 1978a). These artefacts are understood as the signs, tools and language facilitating interaction with the environment (Conole, 2015).

The design approach commences with considering appropriate pedagogies assuming a prior analysis of the curriculum requirements, and a study of the prospective target population. The pedagogic mix is defined with consideration to the intrinsic features of the pedagogic perspectives, eloquently summarised by Mayes and de Freitas (2013, pp.19–24) as ‘associationist’, ‘cognitive’ and ‘situative’. Beetham (2013a), while analysing these pedagogies, makes an important conceptual distinction: curriculum activities can be defined as tasks designed by teachers, but learning is materialised through the learner’s engagement. Learners approach tasks in a variety of ways according to their individual interpretation of the task, and it is through engagement that learning takes place. Consequently, learning is a highly individualised experience affected, among others, by the individual’s personality and prior experiences. Therefore, tasks can be interpreted as a frame/unit of reference, or mediating artefact, that enable learning by providing a description of the requirements. Beetham (2013a, p.33) then proceeds to define a learning activity as ‘*... a specific interaction of learner(s) with other(s) using specific tools and resources, oriented towards specific outcomes.*’ Learning activities should be considered within the context of communities of practice and society, in general, as learners operate within the established norms and within the constraints of the learning environment (Conole, 2015). Beetham (2013a, p.34) applying Engeström’s (1999b) activity theory to learning activities, models Masterman’s (2013) findings on teachers’ design practices as the sum total of a dynamic system. The environment and the interactions of the various components of a learning-activity system must be examined when considering approaches for the operationalisation of the digital-literacy development. The models, processes, and associated tools have been constructed in an attempt to systematically document the operationally important aspects of this system, framed within the realities of the institution.

The digital-literacy learning activity alignment tool [TOOL_12] merits further investigation as it links digital literacy with the cognitive domain. This tool has been developed by bringing together the work of Anderson (2001), Krathwohl (2002), Churches (2009) and Heer (2014). A key tenet of the proposed approach is posited here, affirming that digital literacy, in contrast to digital skills, can only be developed within specific contexts and by engaging other cognitive capabilities. Churches (2009) digital reinterpretation of Bloom’s (1984) taxonomy is used to describe the principal elements of learning development as it is fundamental to learning and can be used successfully as a basis for curriculum design. This model proves useful if considered in the context of digital-literacy development. Technology-enhanced, problem-based learning activities can follow Bloom’s (1984) developmental taxonomy. Anderson et al. (2001) restructure of Bloom’s original taxonomy expressed the learning pyramid in verbs rather than nouns and declared that creativity is higher than evaluation within the cognitive domain. Krathwohl (2002) defined the structure of the cognitive process in terms of 'lower' and 'higher' order thinking-skills starting with a) remembering b) understanding c) applying and developing to the more demanding cognitive processes of d) analysing e) evaluating and f) creating. This structure, considered as one of the fundamental curriculum-development, outcome-based learning approaches (Churches, 2009), can be used to describe in detail the various stages in the process of learning. Heer's (2014) version of educational objectives design has been combined with Krathwohl's (2002, p.214) '*knowledge dimension*' structure following Churches (2009, p.7) revised '*digital taxonomy*'. The resulting model is used as a key feature of the theoretical basis for the curriculum-development approach presented in this thesis. The tool combined learning outcomes as educational objectives with digital literacies mapped across the cognitive domain with respect to the required knowledge.

As it has been identified in the preamble of the curriculum-design model (model 1) the process is pedagogically agnostic and non-prescriptive in terms of the delivery method adhering to the principles of Learning Design (Dalziel et al., 2013). Learning Design as a discipline is concerned with the development of a framework of educational notation that could be used to describe learning and teaching activities and facilitate the sharing of good practices among educational practitioners. As Dalziel et al (2013, p.1) explain in the opening page of the Larnaca Declaration on Learning Design, it aims '*… to convey great teaching ideas among educators in order to improve student learning.*' The learning design is perceived as an abstracted meta-model or framework aiming to describe a variety of learning activities that could be based on different pedagogies and, in this light, it could be characterised as pedagogically neutral (Koper, 2001; Dalziel et al., 2013). The specifics of the delivery of the learning design of each lesson can remain open to negotiation and determined by the teacher or facilitator. The overall approach developed in this thesis aims to align curriculum design, learning design, content authoring and assessment within this model of embedding digital literacy.

6.2.2 Implementation into Practice

In order the approach to account for a range of needs and be applicable in a variety of situations, the models and tools have been designed in a way that would allow their use in multiple modes. Curriculum (re)-development is a time-consuming process, difficult to justify without having unambiguously established the benefits and fully developed the necessary quality-assurance processes. Moreover, as it has been shown in the previous chapters the learners and teachers have shown variable profiles in respect to their technical abilities, engagement with technology, and academic professional-development preferences and practices (see: results of Phase 1 & 2). For these reasons a small pilot project that implemented aspects of the proposed approach in practice reduced the requirement for complete curriculum redevelopment. This project was designed to pilot the issuing of online digital-literacy 'badges' in recognition of the digital capabilities that students acquired by experiencing and successfully completing the modules in their respective programmes of study. The modules shortlisted for the pilot were mapped [ACTION_13] against the set of the bespoke digital-literacy attributes that constituted the necessary qualities to be obtained by the students. A tool [TOOL_07] to map the digital-literacy characteristics of the established curriculum was created (Kerrigan and Evangelinos, 2015). This tool was used to map digital literacy and issue online digital-literacy badges according to the definitions of the institutional meta-framework. Specifically, during the curriculum review-phase course, teams were asked to identify where elements of digital literacy were delivered within their curriculum by identified where and how these have been taught and assessed.

During the implementation unintended, although not unforeseen, quality-assurance implications were identified. The research highlighted the necessity for quantifying the digital-literacy potential of the tutors when asked to deliver the digitally-enabled curriculum. Indirectly it raised questions on how to ensure that the technological-competence requirements could serve a diverse student-body and challenge the highly capable students while, at the same time, the less capable ones would not be excluded. A third aspect, relevant to the previous considerations, was to quantify the digital-literacy requirements of the technology-enhanced curriculum. The alignment of the digital capabilities of the students and their tutors to the requirements of the curriculum was discussed by Walker and Kerrigan (2016) when examining the relations of digital capability, digital complexity and curriculum efficiencies. The proposed approach fits well with their model by creating a common framework, formulating processes and tools to define and measure the digital literacy of students and staff and for embedding digital literacy into the learning activities that constitute the curriculum (Evangelinos, Holley and Kerrigan, 2016).

6.2.3 Staff Development Strategy

One of the strategic aims of the research presented in this thesis is to inform practice which will support the transition of students to learners who have the initiative and responsibility for their own self digital-literacy development. A key part element to support this transition is academic digital capability. Although they are highly qualified professionals trained in pedagogic principles, they exhibited varying degrees of digital capabilities on how to utilise technologies for teaching and learning (see: Figure 47). This observation is supported by Walker and Kerrigan (2016) who identified three intrinsically interlinked aspects to their triangulation model: a) student capability, b) staff capability and c) curriculum activity. However, at the time they did not have a tool to measure these. The digital literacy of academic staff has to be developed to allow them to support the learners in the acquisition of the required digital capabilities in multiple domains including social, professional and academic. Furthermore, their development is required to deliver the model of digital literacy embedded in the curriculum (see: Figure 44), to ensure the constructive alignment of digital-literacy skills and the subsequent design of learning sessions. Finally, it is important the teachers to become able to assess the level of the students' digital capabilities and their own, so as to optimise their designs accordingly. This requires a level of digital literacy higher than that of their students'. The significance of operating within the optimal zones of development for the learners requires the teachers' capabilities to match or exceed the requirements of the curriculum.

One notable challenge, identified in the research and presented in the previous chapters, was that academics and students interpreted digital literacy in their own ways and could only conceptualise digital literacy by reflecting on their own individual experiences (see: Results of Intervention 1). It was also apparent that the level of technical ability and engagement with technology varied considerably. For these reasons the proposed model (see: Figure 44) was supported by an underlying bespoke digital-literacy framework and associated processes and tools that included a self-assessment tool to measure digital capability in terms of the adopted framework.

The staff-specific digital-literacy questionnaire previously developed [TOOL_03] was used to measure staff digital capability and engagement (see: Intervention 3). The results are analysed below in an attempt to explore the optimal development strategies. Engagement was calculated as an index of the self-reported usefulness of VLE tools in terms of teaching. The relative usefulness of each VLE tool was weighed on a scale of 0-5 (in steps of 1) where 0 indicated that the tool was not used and 5 that it was very useful. The index of usefulness was calculated by adding the weighed contributions of the twelve tools, and the value was normalised from -1 to 1. Capability was measured by taking the mean value of the five digital-literacy areas identified in the framework and assessment tool. The data summarised in Figure 47, collected as part of intervention 3 [ACTION_08], demonstrated that the staff had varied degrees of engagement with institutional technologies and different self-professed capabilities.

When staff engagement with institutional teaching technologies is examined in relation to digital capability an informed interpretation of how to best support their digital development needs is acquired. Inspecting staff digital attitudes (engagement) in relation to their digital capabilities (digital literacy) establishes a benchmark of the status quo that can be used to inform staff development and determine the optimal ways of supporting them. In Figure 47 it can be observed that staff fall into one of the four categories namely: a) highly-capable and highly-engaged (top-right), b) low capability but highly-engaged (bottom-right), c) low capability and low engagement (bottom-left), and d) highly-capable but low engagement (top-left). These quadrants can be used to categorise individuals with similar traits and optimise the training programmes or target relevant staff development.

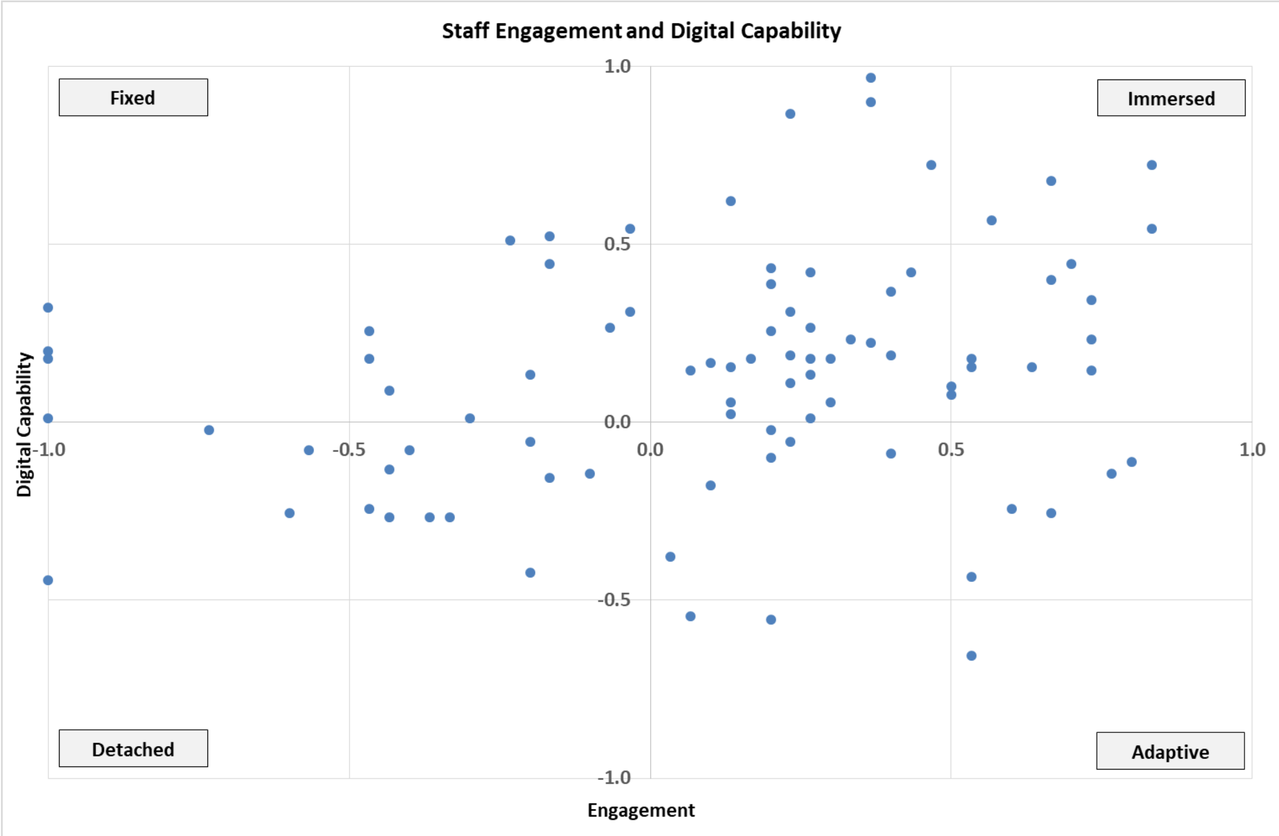


Figure 47 - Staff Engagement and Capability Analysis

The diagram illustrates the staff-engagement and digital-capability indexes plotted against each other. Taking the mid points of the digital capability and engagement scales (here denoted as 0, 0) as a point of origin, four quadrants are defined: a) highly-capable and highly-engaged or 'Immersed' (top-right) b) intermediate-low capability and highly-engaged or 'Adaptive' (bottom-right), c) intermediate-low capability and low engagement or 'Detached' (bottom-left) and d) highly-capable but low engagement or 'Fixed' (top-left).

Research at the University of Greenwich (2013, pp.1–2) found similar results where individuals tended to fall into four groups described as a) Immersed, b) Adaptive, c) Detached and d) Fixed. As immersed is defined someone engaged, inquisitive and digitally capable, or when an individual '*Performs and excels when surrounded by digital technologies and can select, adapt, manage, integrate and use appropriate available digital technologies effectively.*' This quadrant is where technology-enhanced learning and teaching innovation is likely to happen and it is the target, or optimal zone, for continuous development. As adaptive is described one with the ability to adjust within a digital environment and specifically an individual that '*Demonstrates skill and understanding in deploying appropriate digital technologies and can quickly learn new tools.*' This is the zone of focused development and support as it identifies the individuals willing to enhance their digital skills, are engaged and understanding of the benefits of using digital technologies in their teaching. Detached are the people who do not readily engage within the digital domain and are depicted as persons that '*Lack basic knowledge or exposure to digital technologies from an early stage.*' This quadrant constitutes a challenging area since this group of individuals are neither capable nor engaged and significant effort and resources are required to up-skill them into working with technologies and make them competent in implementing technology-enhanced teaching pedagogies. Fixed are the individuals who have remained static and do not actively cultivate their digital capabilities or apply them into practice. These individuals are characterised as '*Resistant due to the result of an informed "opt out" or lacking in the knowledge or incentive to develop further.*' This is the area of opportunity as these people normally have intermediate to high digital capability and may be more or less engaged in applying it into practice. What characterises them is often the lack of aspiration to engage, rather than the lack of digital capability or understanding. Lack of aspiration should be interpreted widely as it often derives from a number of personal, professional and organisational factors.

Combining the research presented here with the results deriving from the work done at the University of Greenwich, it is possible to group academics and subsequently develop a model to support their professional development aligned to digital literacy. Since it was established that digital competence and engagement varies among academic staff, a practical question on how to best support the development of their technological skills and technological-pedagogical competency (Koehler and Mishra, 2009) arose. Drawing from the data presented in this thesis (see: Figure 47) a possible process to optimise the institutional staff-development offerings for the purpose of supporting the implementation of the model is proposed. The aim is to support the development of digital competencies, facilitate implementation into practice, and maximise the impact. For this reason, a model of staff development (Model 3), illustrated in Figure 48, was created by mapping the staff-development approaches onto the classification system developed by the University of Greenwich (2013). This model is founded on the staff digital-competency and engagement data and supported by the questionnaire tool [TOOL_03] previously developed.

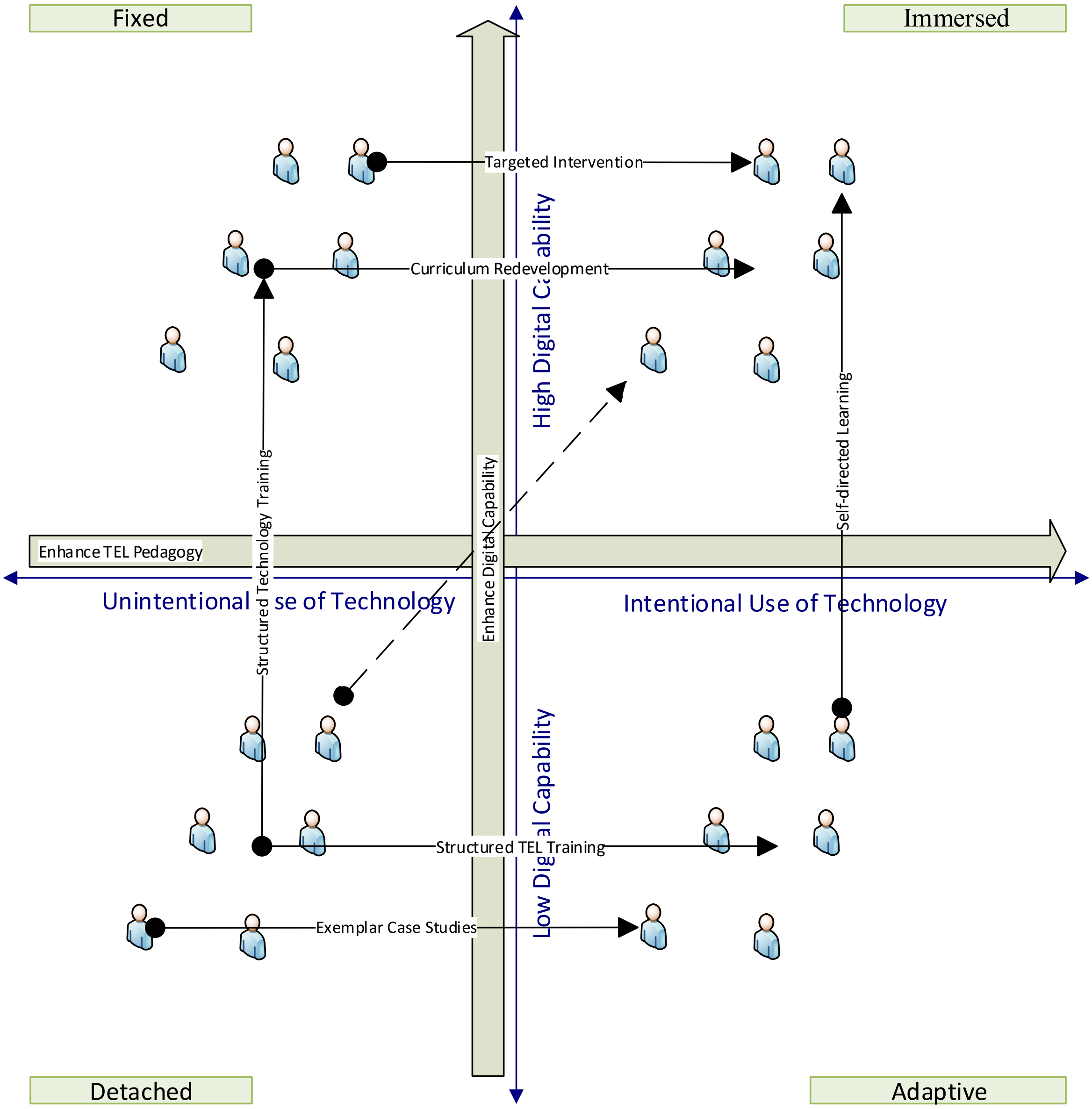


Figure 48 - Staff Development Strategy (Model 3)

The staff development-strategy model. The horizontal axis represents the intentional or unintentional use of technology expressed in terms of engagement, and the vertical axis represents the digital capability measured in terms of the DigComp$_{v1}$ digital-literacy framework articulated in the previous chapters. The four quadrants characterised the individuals as a) Immersed, b) Adaptive, c) Detached and d) Fixed, according to their levels of engagement and technological capability.

Two main themes run along the axes to drive staff development: a) the enhancement of the TEL pedagogy (x-axis) and the digital capability (y-axis). In this abstracted visualisation the development modes have been depicted as perpendicular to each other for simplicity but it is acknowledged that in reality individuals can potentially move in any direction on this plane. It is also recognised that individuals develop in both domains simultaneously as digital capability is acquired within certain contexts and in a variety of environments. The training programme and interventions were structured to develop the application of technology-enhanced pedagogies and teaching methods, and enhance the digital capability. Moreover, the data underlying this conceptual model represented only a snapshot in time as it could not be practically monitored continuously to identify the developmental trajectory (see: Figure 47). It must also be noted that the training and support modes should not exclusively be offered to specific groups but recommended as the most appropriate ones since they have been designed to match the groups' digital-capability and engagement characteristics. In practice, individuals should be given access to all training opportunities and advised to attend the ones that best match their individual preferences and requirements.

To deliver the proposed model of staff development, six modes of training and support have been identified based upon their complexity. These are listed below in descending order starting from the most complex and resource intensive from an institutional perspective and moving down towards the least complex ones:

I. Curriculum (re)development
II. Targeted interventions
III. Structured pedagogical and TEL training
IV. Drop-in support sessions
V. Exemplar Case Studies
VI. Self-directed technology training

Curriculum development or re-development is the most advanced and desired mode of operation where the curriculum is revised and optimised according to the specific disciplinary and institutional requirements. The implementation models presented earlier (Models 1 & 2) have been designed with a comprehensive curriculum-development in mind but in such a way that could allow for their partial redevelopment or review. As it is shown in Figure 45, there is continuous curriculum development and refinement as part of the quality assurance process. This was included out of necessity due to implementation constraints, since it would not be practical to attempt complete re-designing of all courses within an operational institution. This development mode targets to course teams utilising the model to its full extent, whereby a holistic approach to curriculum design is adopted, starting from the high-level programme objectives and working through to individual-module outcomes, lesson plans, activity designs and, most important, assessment (see: Figure 44). This approach aims at transforming the curriculum by offering and enhancing student attainment, and by creating a modern, technologically-enriched and engaging experience. This is where transformation and innovation happens, but it requires sophisticated technological-pedagogical knowledge in order to be applied in practice. As such, it is optimal for academics 'emerged', or 'digitally competent and engaged' in technology-enhanced teaching practices.

Targeted or partial curriculum redevelopment and enhancement interventions are the next training mode where areas of activity are redesigned to address an identified issue, or because of some other internal or external driver. This research was carried out in this mode by conducting a series of interventions to explore the potential and limits of a change management process and collect evidence to model best practices. In the context of embedding digital literacy in the curriculum this mode has been employed within the institution to implement externally-driven change and to meet quality-assurance standards. Targeted interventions are best suited to situations where the individuals are digitally capable, but use technologies in their teaching without necessarily aligning them to pedagogy and to their teaching-delivery approaches, or without having a clear understanding of how to enhance learning in practice. This group of academics has been characterised as 'fixed' as, although they may be utilising reasonably complex technologies, they are doing it out of habit, or even necessity, without a clear purpose or conceptual understanding of how these should be used to facilitate the development of their students. Targeted interventions will help to further develop academic-teaching practices and importantly help academics to appreciate why and how technologies can be used intentionally to enhance teaching practices, or achieve some other specific outcome, such as to address operational or performance issues.

Another form of development is through the delivery of structured technological and pedagogical Technology-Enhanced Learning and Teaching (TELT) training. This mode of training is best suited to individuals who have been identified as requiring further improvement of their digital skills and will benefit the most after gaining a better understanding of how to align technology-use and teaching practices. In the training-strategy model these groups have been depicted as 'detached' and 'adaptive' where individuals appear to require significant improvement of their digital capabilities and need to enhance their understanding on how to use technology-enhanced teaching methods appropriately. Its advantages include a familiar format of facilitated training where individuals participate in a structured training-programme, are taught what they need to know, and are given an opportunity to experiment. However, the disadvantages include people's tendency to becoming disinterested in relatively generic training sessions, especially if the participants do not consider the topics relevant to their needs or cannot see ways of applying them into their own practice. Another major drawback is the perception that this type of training is an institutional requirement not necessarily beneficial for the development of the participants. Nevertheless, it is of significant value when large numbers of people need to be up-skilled, and a resource-efficient way for raising the average level of competency across large groups. The actual impact of this type of training in practice does not often become instantly obvious since the participation does not necessarily lead to meaningful enrichment, or transformation of the actual practice. However, it is a quintessential, most resource efficient mode of training and can be used as a stepping stone for the participants to acquire the knowledge and understanding needed for their progress and further development.

The use of exemplar case studies, although they do not constitute a training mode, is nonetheless useful in attracting attention and stimulating interest. Pertinently, as these examples of technology-use have been implemented into practice by other academic practitioners, they are perceived as authentic examples of how theory can be translated into practice by a group of peers and, as such, they enhance the likelihood of adoption. The use of exemplar case studies within the model of staff development is best suited to academics characterised as detached. This group exhibits relatively elementary digital-capability and are not engaged in the technology-enabled learning and teaching practice. Case studies can be used to raise awareness and potentially trigger their interest in engaging in TEL pedagogies and modes of teaching delivery which in turn may encourage them to participate in further training to enhance their digital skills and apply them into practice.

A key method that should be at the core of all staff development is the encouragement of self-directed and independent learning as the only efficient option for keeping up-to-date with the rapidly evolving technologies and following-up of the latest innovations in their use for learning and teaching. Academics and academic professionals should be empowered to become self-directed learners as this necessity is increasingly becoming imperative in all aspects of technology use. Importantly, within the HE sector, academics need to become proficient in the use of technologies to facilitate and enhance learning, and use technologies within their various disciplines.

The proposed training strategy is optimised to identify suitable approaches and facilitate the development of staff. It is important to note that, although the analysis of the digital capabilities of the staff and their engagement proved useful in modelling the training strategy, the model was constrained by the available data and had to be simplified to the fundamentals that could be evidenced. In reality, the process of staff development and optimisation of the strategies is appreciably more complex as it depends on numerous factors other than the digital capability and a single measurement of technology engagement. Nevertheless, this approach is the first step towards establishing a ubiquitous model for the digital-literacy curriculum development supported by a comprehensive staff-development programme to be embedded into academic practice and provide measurable evidence of its impact.

The embedding of digital skills in the curriculum is best carried out within a disciplinary context and the respective professional environments dictate the type of technologies, as well as the depth of competencies that need to be acquired (Leeds Metropolitan University, 2011). Knowledge and understanding of the ways technologies are used in the respective disciplines are also important as learning and development always happen within specific contexts and are inherently influenced by social, professional, personal, and other environmental interests and values (Beetham and Sharpe, 2013). It is important to keep in mind that the pace of technological innovation may differ significantly across the disciplines and it may materialise at different points in time, so the staff should develop their digital skills and competencies in both domains, academic and disciplinary, simultaneously. The manifestation of disruptive technologies can drastically change the way a discipline operates and, in cases, it can change the discipline from its bases (Schwab, 2016). From an institutional perspective, the staff-development strategy aims to enhance the digital capabilities of all staff and facilitate measurable change in practice. This change in practice will help to ensure that universities remain aligned to their students' needs and the professional (work) markets they support (Organisation for Economic Co-operation and Development (OECD), 2018).

In conclusion, the staff development model proposed in this thesis was developed to support the implementation of the model and the associated processes elaborated in the earlier chapters. The development of the digital capabilities of students and staff through appropriate utilisation of technology is of paramount importance in higher education (Scott, 2015a). Students increasingly consider digital engagement as an important factor for their studies and seriously take into account the digital capabilities of their teachers when selecting where to study (Davies, Mullan and Feldman, 2017; Joint Information Systems Committee (JISC), 2017d). Knowledge and understanding of how technologies are used within the disciplines are also required since the pace of technological innovation and subsequent change have been escalating to such unprecedented levels and extent that some consider the phenomenon as the fourth industrial revolution (Schwab, 2016).

Chapter 7. The Curriculum as a Strategic Asset

7.1 Discussion and Reflections on Professional Practice

The overarching question this research addressed was, 'How can digital literacy be conceptualised and embedded into a variety of learning scenarios?' The conceptual model, presented in a simplified form in chapter 2 (see: Figure 5) of this thesis, illustrated in Figure 49, shows how the research was framed, portrayed in general institutional terms and considered in relation to the external and internal environments. The main area of interest, originating from a societal need, is the development of digital literacy, an intrinsic part of what is often called the 21st Century Skills (Department for Education and Skills, 2003; Binkley et al., 2012; Voogt and Roblin, 2012; The Partnership for 21st Century Learning, 2015; van Laar et al., 2017; Martin, 2018). This work-based research aimed to establish a model, processes and tools to operationalise the development of technology-enhanced learning opportunities. The research spans across three main areas identified as internal to the institution: a) the curriculum design and delivery, b) the digital capabilities required by teachers, and c) the establishment of quality enhancement and assurance processes and metrics.

The conceptual model, illustrated in Figure 49, was based on the premise that digital literacy can be fostered by learners engaging in activities (depicted in the model as DLTEL activities) that have purposefully been designed to deliver the curriculum outcomes, as well as on digital skills (Leeds Metropolitan University, 2011; Thomson et al., 2014). When students undertake these activities as part of the curriculum, they develop skills and competencies in a number of domains where their experiences are formed. The students' interactions with the curriculum are modelled within the auspices of Activity Theory (Engesgröm, 1987; Cole, Engestrom and Vasquez, 1997; Engeström, 1999a; Engestrom, Miettinen and Punamaki, 1999) by acknowledging the multi-dimensional nature of experience and learning as it is manifested through a variety of socio-emotional aspects (Jonassen and Rohrer-Murphy, 1999; Koper, 2001; Attwell and Hughes, 2010; Engestrom, Miettinen and Punamaki, 2012). These student interactions with the institution establish the perceived status quo and can be designed to establish a number of quantifiable metrics. These metrics quantify aspects of the delivery, inform the design, and formulate the basis for an institutional quality-enhancement process.

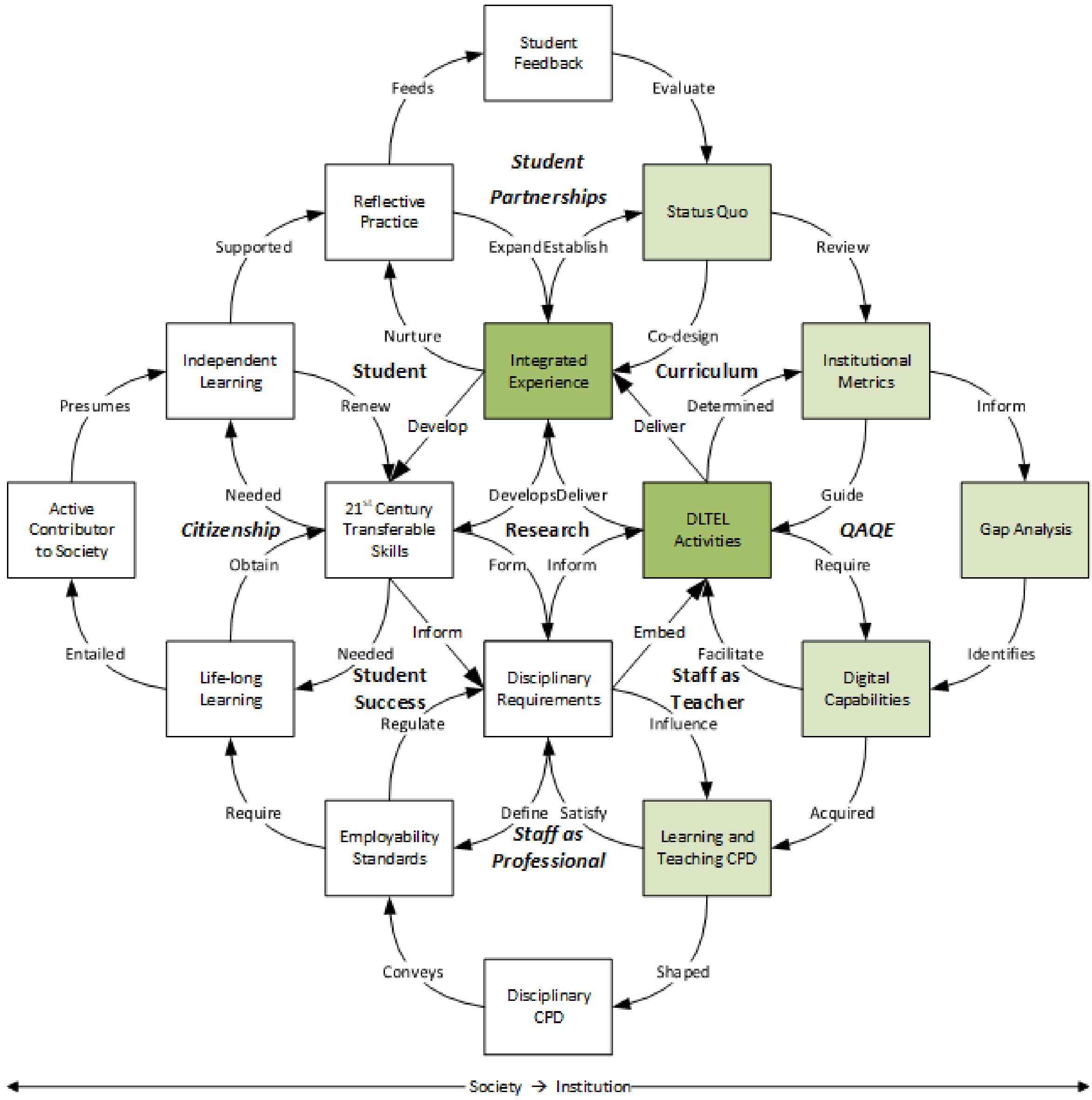


Figure 49 - Digital Literacy in Higher Education Conceptual Model

The model depicts the concepts that are driven by societal demands external to the institution on the left-hand side of a hypothetical vertical line drawn at the centre. Conversely, the concepts portrayed on the right-hand side of this notional line are directly owned or, at least, in partial control of the educational institution. The areas identified in green are the main concepts that have been explored through the work conducted in this thesis. Specifically, the research focused in the areas of curriculum design, quality enhancement and to a lesser extent staff development.

In this research the institutional status quo was examined by benchmarking the digital capabilities and experiences of students when undertaking technology-enabled learning activities within the formal curriculum. The potentials and limitations of embedding digital literacy in the curriculum were explored in relation to establishing institutional processes and metrics by operationalizing the design of technology-enhanced learning opportunities. It emerged that the digital capabilities of academic professionals are key factors for the successful implementation of such a model. This was in resonance with much of the relevant literature reviewed at the time of commencing this research (Anyadi et al., 2013; Gourlay and Oliver, 2013; Robinson and Kilcoyne, 2013; Velden and Anagnostopoulou, 2013). Academics must become competent in the digital requirements of their respective disciplines and develop their competencies in technology-enhanced teaching since they are the designers and facilitators of the curriculum activities. This parallel development will encourage a broader understanding of the needs of a discipline and it will be considered from a teaching and learning perspective. Disciplines have their own prerequisites of what constitutes an employability requirement in terms of digital literacy, and how these translate into practice (Doodson and Eynon, 2013; Gourlay and Oliver, 2013; Follows and Turner, 2013; Francis, 2013; Kerrigan et al., 2013b; McDermott, Witt and Stillwell, 2013; Robinson and Kilcoyne, 2013; Velden and Anagnostopoulou, 2013). In some cases, the existing paradigmatic conventions specify the expectations and, sometimes, the assessment methods and standards that form parts of the professional requirements.

Under a broader perspective, purpose of the institution is the creation of an environment conducive to learning, and the safeguarding of the academic standards that increasingly tend to involve the development of digital literacy among other 21st century skills (Maxwell, 2014; Scott, 2015a; P21 Partnership for 21st Century Learning, 2017). From a learner's perspective the main motivation should be learning and the development of skills. The increasing marketization of higher education has created a competitive environment whereby the focus has shifted from learning and development to a more consumerist, transactional understanding of students' studying at an institution, so as to achieve their desired outcomes that often translate to acquiring a degree or other qualifications (Molesworth, Scullion and Nixon, 2011; John and Fanghanel, 2015; Lynch, 2015; Nixon, Scullion and Hearn, 2016). Academic institutions are judged in terms of their academic research output and student satisfaction (Higher Education Funding Council for England, 2015), employability and other related metrics (The Higher Education Statistics Agency, 2016). The Department for Education (2016) established the Teaching Excellence Framework (TEF) in an attempt to evaluate teaching excellence and graduate outcomes. At the same time, efforts to enhance the student experience by offering an inclusive, integrated and stimulating learning environment have broadened the scope of education beyond that of the historic requirements of the formal curriculum (Department for Education, 2016).

Operating within an increasingly competitive and volatile socio-economic environment, the operationalisation of a process of curriculum design for the embedding of digital literacy through the application of the learning design and the activity theory lies at the core of this research. By designing learning opportunities or activities that develop cognitive capabilities (e.g. remembering, analysing, evaluating) and seamlessly delivering the disciplinary curriculum requirements alongside co-curricular (The Higher Education Academy, 2017) and transversal skills (e.g. numeracy, data literacy, language), competences and attitudes (e.g. digital literacy, sustainability, inclusivity), the formation of an evidence-basis for the purpose of acknowledging a learner's performance and the recording of their individual development in multiple domains becomes possible.

The delivery of learning activities designed according to the proposed model (see: Figure 44) will establish an evidence basis for the students' interaction with the institution and their corresponding digital-literacy development. At the same time, as learners experience the integrated curriculum, they will develop quantifiable competencies within the various digital domains as these are articulated in a digital-literacy framework. This is important as student success is often defined in terms of meeting the disciplinary requirements, acquiring employability qualities and becoming life-long learners. Indeed, national league tables, TEF metrics and DLHE statistics are all collected in relation to these key performance indicators. Traditionally in higher education students are expected to develop the most of their academic skills, become reflective, independent learners and ultimately professional practitioners. Such an approach is thought of as increasingly important as the requirement for a number of ubiquitous qualities becomes emergent (Fung, 2017; Marshall, 2017). Student partnerships and their involvement in the curriculum design is essential in promoting engagement and ensuring that students form a strong entity as part of the institution and in becoming co-creators of academic knowledge where appropriate (Healey, Flint and Harrington, 2014; Joint Information Systems Committee (JISC), 2017a; b). The institution can greatly benefit from empowering students in terms of enhanced engagement and quality of feedback.

The institution should also ensure that, through the curriculum, the learner is offered a diversity of learning experiences and the opportunity to develop holistically. Activities should be documented in sufficient detail so as to be easily reproduced, and should be explicitly linked to the teaching material (Galley, 2011; Cross et al., 2012a; Conole, 2014). Pedagogies should be at the core of the design activity. The teaching methods should be appropriately documented through learning designs and aligned to assessment and the outcomes of the curriculum. Through recording each learner's attendance, engagement and attainment, the creation of a data-basis necessary for a personalised approach to the participant's learning development will become possible since the learner will have to be undertaking activity-based tasks at regular intervals. Processes and tools should also be established to allow the documenting of the curriculum and the monitoring of individual student performance in terms of learning attainment and development in tandem with attendance and engagement (Galley, 2011; Cross et al., 2012a; Conole, 2014).

As it was demonstrated by this research on the student experience, the formal curriculum delivery should blend seamlessly the classroom activity with a continuous online delivery approach and provide personalised support to each learner. Standardised testing tools and assessment methodologies can be used to document the learner's development over time and provide insights that will allow a personalised approach to teaching and academic support. Learning activities will be used as an instrument for the definition of expectations of a learner's engagement with the curriculum elements, and upon assessment they will produce evidence of attainment. Specification of the curriculum in sufficient granular detail will constitute the basis for devising indicators and establishing metrics for the evaluation of engagement and attainment for each student, evidenced by their assessed performance. The learner's performance on the tasks and the frequency of engagement will be used to measure how the learner engages with the elements of curriculum and what has been achieved. This approach will enable a more intelligent and efficient method of targeting and personalising academic support.

Looking into the potential, future use of the proposed models deriving from this research, there is a growing body of work in relation to using big data for learning analytics within education to support institutions in quantifying engagement and managing learners' progression (Tobarra et al., 2014; Tempelaar, Rienties and Giesbers, 2015; Rienties, Cross and Zdrahal, 2016). Engagement data generated through the use of Learning Management Systems (LMSs) (Wolff, Zdrahal, Nikolov and Pantucek, 2013; Rienties, Toetenel and Bryan, 2015), including technologically-mediated assessments for learning (Wolff et al., 2013; Papamitsiou and Economides, 2014; Tempelaar, Rienties and Giesbers, 2015) alongside other attainment and socio-economic information, can be used to extrapolate learners' profiles and predict learning behaviours (Calvert, 2014).

Although significant progress has been made in utilising data analytics to quantify learners' engagement and progress in recent years, learning analytics is an emerging discipline still being defined in terms of concepts, limitations and methods (Arnold and Pistilli, 2012; Papamitsiou and Economides, 2014; Rienties, Cross and Zdrahal, 2016). There is evidence that the interpretation of the data indicators and their translation in meaningful, reliable information is a complex process that needs to be explored further (Papamitsiou and Economides, 2014; Conde and Hernández-García, 2015; Tempelaar, Rienties and Giesbers, 2015). Rienties et al. (2016) at the Open University (OU) in the UK proposed a framework for learning-analytics evaluation in an attempt to standardise an evidence-based approach to learning interventions that will enhance the validity of the results and crucially allow generalisation and transferability of knowledge. The implementation model proposed in this thesis is in resonance with the broad principles and approaches outlined in the OU's Analytics4Action evaluation framework (Rienties et al., 2016).

Following a similar approach, it is proposed the curriculum elements within a course to be defined systematically and in sufficient detail as technology-mediated learning opportunities (Conole and Weller, 2008; Conole, 2010b; Cross, Galley, Brasher and Weller, 2012b; Rienties, Toetenel and Bryan, 2015) and form the basis for establishing quality-assurance and enhancement metrics. The metrics can be used across multiple domains to manage curriculum delivery, enhance and assure quality and inform strategic planning. In relation to digital-literacy development, Walker and Kerrigan's (2016) model which is stipulating the need for aligning the digital capabilities of staff and students with the requirements of a technology-enhanced curriculum, has been adopted. The work carried out in this thesis proposes an approach to curriculum design and delivery that can be used to implement these conceptualisations in practice. The establishment of a common digital-literacy framework alongside the operational model, processes and associated metric tools provided the basis and evidence of exploring the institutional status quo. It also enables the quantification of the digital capabilities of students and staff and documents the digital requirements of the curriculum. The information arising from such institutional metric data can be used to optimise the curriculum (re)-development, provide evidence to identifying the appropriate professional development of the academic staff and ultimately enhance the student engagement, attainment and experience.

7.2 Outcomes, Limitations and Contribution to Knowledge

The overall aim of this localised, work-based, case-study research was to explore how the development of digital literacies could be facilitated within a higher education institution. The initial research question attempted to define digital literacy in relation to the key stakeholders (students, academics and academic-related professionals). A sub-question, on whether any specific attributes in healthcare education existed, arose during the inquiry.

Q.1 Are digital literacy frameworks useful in supporting student learning in university healthcare settings?

Q.1.1 Are there any specific attributes of digital literacy in a healthcare education environment?

To answer these questions a divergent approach was taken in exploring the use of the European Union Digital Competence DigComp framework (Janssen and Stoyanov, 2012; Ferrari, 2013) as, at that time, it was deemed to be a new, promising and flexible approach in defining digital literacies. Although the framework was not conceptually or significantly different from other nationally and internationally recognised and established approaches (Beetham, McGill and Littlejohn, 2009; McGill and Beetham, 2015) it was expressed in a granular way that defined digital literacy at multiple levels and identified examples of how its conceptual elements were translated in practice. The granularity of the framework and the linking of the conceptual themes to examples of practice were innovative and could be used ubiquitously to describe digital literacy within the institution (Evangelinos and Kerrigan, 2016).

The inquiry commenced with examination of what digital literacy meant to students, academics and academic-related professionals. A qualitative exploration of the DigComp$_{v0}$ (Janssen and Stoyanov, 2012) framework within the institution was conducted in an attempt to assess its applicability for investigating the potentials and limitations for embedding digital literacy into the healthcare curriculum-development and delivery (Evangelinos and Holley, 2014a). The results, discussed in more detail in the conclusion section of Phase 1 - Intervention 1, showed that there was sufficient evidence to conclude that the DigComp$_{v0}$ framework was sufficient, although not optimal, for describing the digital characteristics of students and staff within a healthcare educational environment, but there was no significant evidence of any healthcare specific attributes. However, the study of the profiles of learners revealed that they had diverse skill-sets and preferences and that their technology use was driven by necessity. It emerged that learners identified their technological capabilities in terms of their everyday lives and their engagement with technology across work, study and leisure. This observed behaviour was theorised by the hypothesis that technology use is the product of fulfilling some practical requirement, and non-experts do not conceptualise it in generic abstract terms. In cases, technology may also be the topic of study but this does not preclude its utilitarian capacity. It also emerged that digital literacy is a general term that signifies competency in using digital technologies, but its meaning is wide-ranging and not specific enough without further interpretation. A significant risk was recognised in that the participants would not be able to comprehend digital literacy as an abstract, higher-level concept. Consequently, it was decided that further elaboration on what digital literacy meant was required to enable the establishment of a common frame of reference among the researcher and the research participants. This frame of reference had to be defined in a meaningful to the participant way, so as to enable the provision of evidence in practice. For these reasons it was decided to explore in what ways a framework approach could enable comprehension on how digital literacies manifest in student learning experiences. At the same time the question of how digital literacy can be developed arose.

Q.2 In what ways can a framework approach assist us to understand how digital literacies manifest in student learning experiences?

Q.2.1 How can digital literacy be developed in a higher education healthcare environment?

Phase 1 - Intervention 2 (Investigate and Innovate) was enacted in an attempt to quantify the characteristics of digital literacy in health education. Evangelinos and Holley (2014a, 2015a) found that the DigComp framework was applicable as a generic framework for use in education. The interview data indicated highly individualised digital-literacy characteristics and behaviours of the participants. Due to the nature of the inquiry and the complexity of educational processes, the approach included a measurement of students' self-assessed attitudes towards technology (Evangelinos and Holley, 2014b) and a more in-depth exploration of self-assessed skills and technology-use experiences (Evangelinos and Holley, 2015b). Analysis of the questionnaire results found that the data could quantitatively evaluate the general level of digital literacy of groups and produce maps of their digital-literacy characteristics.

Phase 2 - Review and Enhance (interventions 3 and 4) explored the potential and limits of the revised questionnaire tools. The measurement instruments based on the $\mathrm{DigComp}_{\mathrm{v1}}$ taxonomy offered a more robust way of documenting the digital literacy of students and academics as a series of competency statements and scenarios. Exploratory statistical analysis of the results showed convergence to one primary concept postulated to be that of digital literacy. However, the analysis indicated that the scenario-based response format, based on the $\mathrm{DigComp}_{\mathrm{v1}}$ definitions, was arguably limited in resolution. Examination of the performance of the concept-scales in use showed that some of the questions could be further refined in relation to the use of language and terminology. Generally, both versions of the questionnaires showed that they were internally consistent, although it was recognised that further research would be needed to unequivocally establish their reliability. A larger-scale study, based on a more representative sample of the higher education population as a whole, was recommended in order to establish statistical power and allow for the conclusions to become generalized. It was also recognised that terminology and approaches to assessing digital literacies might have to be adapted, to better match the requirements of a discipline and its purpose of use within higher education. The questionnaires have been developed as exploratory tools aiming to create baseline evidence of digital capabilities but, in their current form, they should not be used as confirmatory assessments of digital capability.

Students reported significant and varied uses of technologies in their private, academic and work lives (Evangelinos and Holley, 2015b, 2016a; b). However, special consideration is needed when the activities of the curriculum content are designed to engage and nurture the digital skills of the learners. Digital activity should be balanced to maximise the acquisition of technological competence within dynamic environments in a variety of situations including work, study and in private life. By utilising learning designs the technology-enhanced learning opportunities can be mapped alongside the curriculum content on the digital capabilities and skill requirements of the learners and teachers. The development of student digital literacies should take into account an individual's digital capabilities within the wider social context and within the work or learning environment in particular. It also became apparent that the divergence of the individuals' profiles required careful consideration to ensure that the technology-enhanced learning activities were challenging and inclusive. Informal training and formal support should be provided with the focus at developing the students and academics so as to become digitally self-sufficient, life-long learners.

In the context of this research the questionnaire tools were used to establish the digital literacy of students and academic staff. The developed metrics offer an assessment of digital literacy which, when combined with an analysis of technology-use and examination of the student experience, built a more complete picture of the participants' digital profile and capabilities (see conclusion of interventions 2, 3 and 4). These tools, when fully validated, could be utilised to balance/optimise the requirements of technology-enhanced activities used to embed digital literacy in the curriculum, and the learners' digital capabilities. Once a common language to describe digital literacy was established, and tools to quantitatively measure digital literacy in practice had been developed, the question on how to best implement these in a model for embedding digital literacy in the curriculum evolved intuitively.

Q.3 How can digital literacy be conceptualised and embedded into a variety of learning scenarios?

Q.3.1 What are the necessary elements for embedding digital literacy in curriculum development?

Model and Operationalise - Phase 3 of this research devised a model, processes and tools for embedding digital literacy in curriculum development. Beetham and Sharpe (2007, p.29, 2013) adapted Engeström's (1999b) activity theory to model learning as '*a specific interaction of learner(s) with other people, using specific tools and resources oriented towards specific outcomes*' operating within a complex environment. Adopting a similar theoretical stance, the proposed digital-literacy development model operates on the assumption that digital literacy is cultivated when technologies are used purposefully to achieve results within specific contexts. In this light, digital literacy is the expression of cognitive functions manifested in the digital domain. Digital skills can be acquired in a number of ways but are of limited use when they are not governed by the cognitive functions contextualised within a specific domain. This is because what is important is the application of the digital skills to achieve a result appropriate to the context and not the mere acquisition of technical capability. Achieving a specific result in the digital domain will inadvertently utilise a variety of cognitive functions alongside the digital skills and will describe the breadth and depth of the capabilities required. The variability of preferences and capabilities of the learners and teachers should be carefully considered when optimising the delivery of the learning objectives within the learning environment. For these reasons, it became apparent that the curriculum should be designed in a way developing digital literacy holistically as an intrinsic feature of the learning and teaching activity.

The overall objective of the research was to embed digital literacy in the curriculum and enhance the digital literacies of students and staff. The tangible outputs of this research were:

a) An exploration of curriculum-development through a learning design model,
b) identification of the related processes,
c) the provision of digital-literacy definitions and examples that were later used to co-author the institutional framework, and
d) tools for embedding digital literacy in the curriculum design and delivery.

Phase 3 synthesised the evidence and results that arose from the previously reported research work, and modelled a process for embedding digital literacy into the curriculum development. Evangelinos and Kerrigan (2016) defined digital literacy as a set of attributes and identified exemplars of the competences and skills relevant to higher education according to the DigComp$_{v1}$ taxonomies. This work formulated the basis for establishing a bespoke institutional meta-framework (Kerrigan and Evangelinos, 2016b) that drew from the EU Digital Competence DigComp$_{v1}$ framework (Ferrari, 2013) and the Jisc-funded project Digital Literacy in Transition (Kerrigan et al., 2013a). A pilot-project base-lined the digital-literacy profiles of a small number of modules in an attempt to explore the status quo within the institution, produce the necessary tools for quality assurance and base-lining (Kerrigan and Evangelinos, 2015), and acknowledge the digital-literacy development of students by issuing online digital badges (Evangelinos, Holley and Kerrigan, 2016).

The curriculum-development model, processes and tools have been developed to facilitate the embedding of digital literacy into the curriculum by utilisation of technology-enhanced, activity-based learning designs. It should be noted that, although initially the model focused on the development of digital literacy as an intrinsic part of the curriculum, it transpired that a common process for designing and documenting all curriculum activity, including digital literacy holistically, was necessary. The main reason for this conclusion was the realisation that, by definition, it was not possible to disaggregate the development of digital literacy from the cognitive domain. This is particularly important within an educational environment because its main purpose is to develop cognitive functions and ensure that the graduates are equipped with the knowledge, skills and understanding needed by the wider society in their respective disciplines. This concept was corroborated by the results of Phase 1 and 2 that showed how technology use, and by association digital-literacy development, were inextricably linked to the practical needs of the individuals whose skills, competencies and understanding were individualised and wide-ranging.

Having explored the way digital literacy can be embedded in higher education, it transpired that curriculum development and delivery should be modernised to meet the evolving needs of the society which are characterised by technological innovations, disruptive technologies, and an increasing pace of techno-societal change (Schwab, 2016). The findings emphasised the importance of quantifying the digital literacy of teachers and learners so as to ensure that their digital capabilities were sufficient to deliver the digitally-enabled curriculum and to inclusively facilitate the educational development of a diverse student body. Notably, as Walker and Kerrigan (2016) suggested, it also became apparent that quantification of the digital-literacy requirements and complexity of the technology-enhanced curriculum should be defined from the outset to ensure alignment with the digital capabilities of teachers and learners.

It is proposed that when the models are applied in practice supported by the appropriate processes and mediated by institutional tools, will enable the mapping and managing of the curriculum throughout development and delivery. For example, the elements of the model can be recorded and organised appropriately within the institutional systems so as to formulate a curriculum management-tool to facilitate the conceptual design of the curriculum and produce data for high-level holistic analysis. Nevertheless, the application of the proposed model in practice should be flexible, take into account local priorities and the disciplinary ethos and practices so as to maximise the benefits and its impact.

7.3 Conclusion and Future Work

Digital literacy has historically been interpreted by a variety of conceptualisations relating to how technologies are used within the wider society (Bawden, 2008). In the early days of digital-technology development a narrow interpretation that articulated digital skills as the fundamental aspect of digital literacy emerged (Haigh, 1985). During the past three decades innovation in digital technologies gathered pace and technology-use became increasingly pervasive in all aspects of modern life. It emerged that those narrow elucidations were no longer sufficient. Therefore, the focus shifted away from digital skills to competences and more broadly to digital literacy, or the ability to use technologies to productively participate in society. This conceptual shift had a profound impact on the way digital development was conceptualised, as it transmuted the essence of the requirements away from the mere acquisition of technical skills to the holistic development of digital literacy.

Embracing the concept that digital capabilities were becoming key competences required by graduates in modern societies, it became apparent that universities had a responsibility to ensure that digital literacy was delivered as an outcome of the formal education system (Higher Education Funding Council for England, 2009; Higher Education Academy, 2009; Higher Education Funding Council England, 2015). Taking into account the developments that unfolded in the Higher Education sector in recent years (Joint Information Systems Committee, 2013; Higher Education Academy, 2014; The Leadership Foundation for Higher Education, 2014) driven primarily by Government initiatives and policy (UK Digital Skills Taskforce, 2014; House of Lords, 2015; House of Commons - Science and Technology Committee, 2016), it was decided that further applied research was needed into how the digital literacy of students and staff could be developed within the institution. The research was conducted simultaneously with these developments and was informed by the findings of a significant volume of research that was conducted nationally and internationally by other institutions in respect to the international developments.

Digital-literacy development can be expressed as the manifestation of cognitive processes in a digital space. The aim of education is to develop a number of these cognitive processes and associated skills within the auspices of the different disciplines (which notably constitute diverge paradigms). Digital literacy is not and should not be perceived as another sort of literacy (e.g. numeracy, literacy, logic etc.) but rather as the domain, or digital space, where literacies manifest. An individual operating within this digital space is driven by cognition which can be understood as the sum total of all social interaction with the individual intelligence. The use of technology appears to be directly related with the fulfilment of specific needs which, in turn, are driven by cognitive processes. For this reason, within a learning environment the focus should be on the development of these cognitive capacities in ways appropriate to the discipline, the developmental task and the desired learning outcome or output. Measuring digital literacy has shown that digital capability is intrinsically linked with other operations of the cognitive domain (especially at advanced levels) and, as such, it should be acquired within the context of a constructively aligned, authentic activity.

The data produced by such a curriculum structure, when captured in sufficient detail and in an appropriate time-period, may be used to monitor student engagement and attainment, and generally create a detailed profile of how students develop their cognitive functions, competences and skills in the course of their studies. The model is generic enough and can accommodate a variety of interactions which, if documented in an organised way, will formulate the basis of a new way of capturing the learner's development as it is expressed in terms of predetermined standards that can be traced back in the learning activity, and record the student performance. The crucial point of this process is that, when it is performed at regular intervals, mediated through semi-automated digital processes, it allows for the holistic monitoring of the curriculum design and delivery. More specifically, it will enable the academics to monitor the learning gains of students and devise plans for intervention.

The model presupposes the use of development frameworks that describe and document in sufficient detail the aspects and the required standards of an activity. This should be interpreted broadly across multiple levels and domains, such as task outputs (skills), cognitive capacities (mainly reasoning and remembering), and literacies such as linguistics, numeracy, data, digital, technological, and other. Ensuring a broader constructive alignment of the curriculum-elements will enable the implementation of innovative assessment-strategies that more closely resemble the required skills and competencies of the discipline operating within the wider society. Noting that this does not diminish the fact that learners have varied needs, it is argued that the role of the university is to set and uphold academic standards, and that curriculum-mapping and student performance-data can become significant strategic assets of the institution in their endeavour to maximise the learning gain and evidence impact. This approach is particularly relevant in environments where safety and compliance are critical as the curriculum is often primarily competency-based, but it could also be applied flexibly to suit the needs of other, more abstract, disciplines.

Widening the focus from the institutional environment to society, it is important to consider the changing role of the higher education institutions in the modern, globalised environment. Transferrable skills and literacies are becoming increasingly important as societies change and economies develop. Modelling the learning process within the context of cognitive theory and putting pedagogies at the heart of all educational activities, it is argued that the role of modern education is to accommodate the life-long and life-wide development of learners within multiple domains. From a pedagogical/developmental perspective the interaction of the learner with the institution is exemplified by engagement with the learning opportunities, processes, policies and the immersion of the disciplinary ethos in general. Purposeful design of learning opportunities will ensure that learners will also have the chance to engage with a variety of appropriate learning modes (e.g. associative, constructive, social constructive) and, through these, to develop holistically. This approach to learner development may be aligned to the disciplinary paradigms that are closely associated with the more specific needs of the wider society, but it could also be understood in more generic or transferrable terms, such as those of cognition, literacy, competency and skill.

It should be noted that etymologically the word competence implies the acquisition of capabilities within a competitive environment. In this respect digital competence can be interpreted as the acquisition of digital capabilities within dynamic and competitive environments. The proposed model for curriculum development and management can be used to produce detailed profiles of student engagement and attainment across a variety of educational-development areas constituted by core parts of the disciplinary curriculum, as well as of the co-curriculum, and other transferrable skills and competencies. Once established, these key metrics may be used to classify an individual's performance against his peers', and other historical norms. In this respect big data and analytics can be used to more accurately record a learner's performance and progress (or learning gain) in relation to wider communities.

The proposed model of using big data and analytics to document and explore learning engagement and attainment has legal and ethical implications that must be considered in detail from the outset. The Joint Information Systems Committee (Jisc) (2014) in the UK, consulted by the sector, produced a number of guides ascertaining good practice in the areas of using learner's data and analytics. The consensus is that, when done properly, learning analytics can be conducted legally and ethically for the benefit of the learners and for institutional use.

The researcher has a strong interest in broadening the scope and applying the results of the research into practice by conducting further research to improve the model, the tools and the processes. The institution has established a bespoke digital-literacy framework (Kerrigan and Evangelinos, 2016a) that draws from internationally and nationally recognised good practices and from the work presented in this thesis. The framework has formulated the basis for further developing digital literacies within the institution by embedding them in the curriculum. A digital-literacy audit tool was established to benchmark the digital literacies of staff. Moving forward the framework is to be kept up-to-date and the self-assessment tool to be further developed and revalidated. The development of the digital literacies of the staff will be supported by the provision of generic and targeted continuous professional development. Future research plans include:

a) investigating the staff experiences on embedding digital literacy in the curriculum,
b) assessing the impact of staff CPD model and efficiency of the different routes to support different types of practitioners,
c) assess the applicability of the digital-literacy development tools across different disciplines and
d) evaluate the depth/breadth of digital literacy needed so as one to become 'digitally literate'.

It is envisaged that the model proposed in this thesis will be implemented in practice on a larger scale for the benefit of the learners and the institution. Possibly the development of digital literacy will be assimilated into a wider e-assessment and learning analytics transformation programme, inform curriculum design, identify learners' engagement and performance, allow for an evidence-based approach to resourcing, and personalisation of the teaching and academic-support provision. For successful implementation further research is needed into quantifying the resource implications and putting theory into practice. Sustained efforts will be required to facilitate large-scale institutional change, embed the approach in strategies and policies and eventually establish it as a local practice that will ultimately become a part of the institutional culture.

In conclusion, this work made a modest original contribution in the following manners:

1. Validated conceptually the $DigComp_{v0}$ and $DigComp_{v1}$ digital-literacy framework within a healthcare higher education environment
2. Created and validated two bespoke tools for quantifying digital literacy based on the $DigComp_{v0}$ [TOOL_01] and $DigComp_{v1}$ [TOOL_02], [TOOL_03] digital literacy framework
3. Created a framework for Digital Literacy Badges [TOOL_05] based on $DigComp_{v1}$
4. Co-created a digital-literacy badging framework that was adopted by the institution [TOOL_06]
5. Co-created a digital-literacy curriculum mapping tool [TOOL_07]
6. Compiled a tool for aligning pedagogies and digital literacy [TOOL_08]
7. Compiled a tool for aligning pedagogies and TELT and assessment [TOOL_09]
8. Compiled a tool for re-aligning learning objectives (cognitive domain) to digital literacy [TOOL_12]
9. Created a model (Model 1) for curriculum design [TOOL_11]
10. Created a procedural model (Model 2) for embedding digital literacy in the curriculum [TOOL_10]
11. Created a model for optimising staff development (Model 3) [TOOL_13]

During this doctoral journey the researcher has forged professional relationships with the EU Joint Research Centre – Institute for Prospective Technological Studies (JRC-IPTS) that created the DigComp framework on behalf of the European Commission. Researching the DigComp framework from its inception culminated with the researcher's very modest contribution to the creation of the DigComp 2.0, as part of the stakeholder group in a number of occasions, and in response to invitations of the research centre. Recently the researcher was invited and presented his work on embedding digital literacies in higher education to the European Commission's DigComp stakeholder conference (European Commission, 2017b).

The author of this thesis was recently awarded a University Teaching Fellowship to pursue further research and lead a strategic project in applying parts of this work on digital literacies into local practice.

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APPENDICES

Appendix 1 - Search Strategy

Step	Objective	Repository	Search term	Criteria	Result	Comment
1	Define Digital Literacy	Library Meta Search	digital literacy OR digital competence	Date Range: 01/01/1980 to 10/05/2012	160,454	Search too wide Many irrelevant results
2	Define Digital Literacy	Library Meta Search	digital literacy OR digital competence	Date Range: 01/01/1980 to 10/05/2012 Journals Only English Only	68,967	Search too wide Many irrelevant results
3	Define Digital Literacy	Library Meta Search	digital literacy OR digital competence AND education	Date Range: 01/01/1980 to 10/05/2012 Journals Only English Only	52,591	Search too wide Many irrelevant results
4	Define Digital Literacy	Library Meta Search	digital literacy OR digital competence AND higher education	Date Range: 01/01/1980 to 10/05/2012 Journals Only English Only	48,481	Search too wide Many irrelevant results
5	Define Digital Literacy	Library Meta Search	digital literacy OR digital competence AND higher education	Date Range: 01/01/1980 to 10/05/2012 Journals Only English Only Digital Literacy Tag Only	154	Search rather focused May have excluded useful material
6	Define Digital Literacy	Google	digital literacy OR digital competence AND higher education	Date Range: 01/01/1980 to 10/07/2012	1,280,000	Search too wide Many irrelevant results
7	Define Digital Literacy	Google Scholar	digital literacy OR digital competence AND higher education	Date Range: 01/01/1980 to 10/07/2012 Digital Literacy Tag Only	31,000	Search too wide Many irrelevant results

8	Digital Literacy Development	Library Meta Search	digital literacy OR digital competence AND frameworks	Date Range: 01/01/1980 to 10/07/2012 Journals Only English Only	31,089	Search too wide Many irrelevant results
9	Digital Literacy Development	Library Meta Search	digital literacy OR digital competence AND frameworks	Date Range: 01/01/1980 to 10/07/2012 Journals Only English Only Digital Literacy; Education Tags Only	7,118	Search too wide Many irrelevant results
10	Digital Literacy Development	Library Meta Search	digital literacy OR digital competence AND frameworks	Date Range: 01/01/1980 to 10/07/2012 Journals Only English Only Literacy Programmes Tag Only	510	Search too wide Many irrelevant results
11	Digital Literacy Development	Library Meta Search	digital literacy OR digital competence AND frameworks	Date Range: 01/01/1980 to 10/07/2012 Journals Only English Only Digital Literacy Tag Only	136	Search rather focused May have excluded useful material
12	Digital Literacy Development	Google	digital literacy OR digital competence AND frameworks	Date Range: 01/01/1980 to 10/07/2012	1,110,000	Search too wide Many irrelevant results
13	Digital Literacy Development	Google Scholar	digital literacy OR digital competence AND frameworks	Date Range: 01/01/1980 to 10/07/2012 Higher Education	14,000	Search too wide Many irrelevant results
14	Digital Literacy in UK HE	Library Meta Search	digital literacy AND frameworks	Date Range: 01/01/1980	345	A combination of 41 publications

			AND higher education	to 10/07/2014 Journals Only English Only Digital Literacy Tag Only IN Educational Technology		frameworks and case studies were shortlisted for in-depth review
15	Digital Literacy in UK HE	Google Scholar	digital literacy AND frameworks WITH higher education	Date Range: 01/01/1980 to 10/07/2014	15,300	Search too wide Many irrelevant results
16	Digital Literacy in UK HE	Mendeley	digital literacy AND frameworks AND higher education	N/A	36,572,978	Search too wide Many irrelevant results

Appendix 2 - Jisc Case Studies Developing Digital Literacy Programme

Institution	Drivers	Outputs	Lessons Learned	Sustainability
Cardiff University (Digidol)	The national context promoting information and digital literacy in Wales The institutional context in which information literacy was well established but there was a recognised lack of comparable consideration of digital literacy Implementing the new Education Strategy which identified the centrality of Learning Literacies	Knowledge Hub Learning Literacies Framework Facilitation Toolkit Organisational model Case studies Videos Contributions to strategies Contributions to web resources	Digital literacies must be embedded in practice Appropriate frameworks and processes are essential Strategic initiatives provide leverage but need to be resourced Ensure all the necessary stakeholders are actively engaged	Putting in place a firm foundation for digital literacies to be embedded in staff and student development Creation of a permanent post with responsibility for Digital Enablement Maintaining momentum and engaging with other staff groups
Institute of Education (Digital Literacies as a Postgraduate Attribute)	Develop IOE 'Open Mode' offering: courses offered in an open, flexible, online or distance format Converting face-to-face modules and programmes to new, flexible formats Supporting the development of staff capacities for teaching in distance, online or in flexible formats Updating the technical and administrative infrastructure to support remotely-based students	Project Blog Sociomaterial framework for analysing and shaping institutional change Interactive webinars Mapping Spaces, Tasks and Tools Resources (SEDA) Interactive Library Guide (SCONUL) Exemplar materials: Report, lesson plan, session material	The classic approaches to change management do not always reflect real implementation practice Taxonomic approaches of digital literacy are of limited value as the complexity of reality cannot be fully captured by such classification systems Digital literacy development should be holistic and flexible	N/A

		Key findings report Methodology resource Papers, reports and talks	including an assessment of the external environment and internal constraints	
University College London (The Digital Department)	The changing roles of teaching administrators and their importance in enhancing the student experience within technologically-enabled learning environments The teaching administrator role has transformed to include considerable advisory and developmental responsibilities in supporting best practice, innovation and change A digitally-enabled university necessitates the development the digital literacies of support staff alongside that of academics and students There is a need to recognise the digital literacy of education administrators as a professional requirement in order to enhance the teaching and learning environment	Project Blog Baseline report Student Technology survey report Teaching administration role mapping Digital department qualification Poster HEA CMALT timeline Teaching administration exemplar portfolios Case studies Teaching administration handbook	Teaching administration staff are largely unrecognised and therefore underdeveloped Institutional change complexity requires a forensic approach to changing practices and roles Ensure that there is sufficient support for academics and students Develop networks of professional staff and acknowledge their value Develop productivity support tools (check lists, workflows, process manuals) Cultivate a culture of continuous improvement for support staff Develop targeted training and	Embed findings and best practices in recruitment processes including in inductions of new staff Establish or subscribe to professional accreditation schemes Encourage and resource professional development Produce and disseminate evidence of impact

			development opportunities Recognise and accredit professional practice	
University of Bath (PriDE)	A need was identified to develop student and staff digital literacies as part of the institution's digital environment Students should prepare for the workplace by developing their digital fluency Staff and students needed to acquire new skills because of the fast-paced introduction of new learning technologies Digital technologies are used pervasively in the wider society The digital literacies of students and staff were considered key in maintaining the University's competitive advantage in the marketplace	Discipline-specific statements for digital literacies skills, competencies and attributes Institutional internal baseline audit/report Case studies Project Blog A self-assessment diagnostic tool for students A table of institutional processes Project reports, presentation and Blog reflections	Transformational change management techniques can be highly effective The effectiveness of student engagement and the commitment to continue to focus institutionally on digital literacies The project has exemplified an effective partnership with students in driving forward innovation and taking an institutional approach to the development of digital literacies	Case studies and resources help to change institutional culture Digital literacy definitions, the internal audit tool and list of institutional processes influence change and help to align innovations Evaluation framework for capturing the impact of DL projects can be used to create resources and align innovations
University of Reading (Digitally Ready)	Silos and lack of joined-up thinking Strategic direction Student employability Student engagement Build on existing work and previous achievements	Project Blog Case studies Conceptual frameworks Reports Workshops Evaluation framework	Provide students with opportunities to explore and practise a variety of digital technologies Empower students to take ownership of their project and assume responsibility for producing a	Sustain the process of micro-funding small innovation projects Sustain and further develop the project cross-institutional community of practice Sustain the and further working

			tangible digital output Make digital skills and competencies requirements explicit Develop effective mechanisms for monitoring students' digital skills development Assessment criteria should take into account students' digital skills development Establish recognition schemes for achievements in terms of the digital agenda Students do not automatically adopt and apply technologies to their full extent in learning, scholarship and employer-related contexts Acknowledge the power of student engagement in influencing educational change and innovation	relationships among professional support services and programme teams, academics and students Promote and implement TEL at School/Faculty level and through existing university processes Continue to offer opportunities for staff to develop their digital literacy practice Build upon and further develop student engagement and embed opportunities for developing their digital literacies Create a library of digital literacies practice, guidelines and student stories Sustain senior management engagement
Oxford Brookes University (InStePP)	Strategic commitment to development of graduate attributes,	Recruitment and briefing Reflection tools (ILM, CMALT)	The ePioneer researcher role and the academic recognition	Existing capacity to double the numbers of e-Pioneers

	employability and student engagement Development of staff digital literacies Moving from generic to discipline-specific digital literacies Defining digital literacy	Reward and recognition model Training and development resources (ILM) Project Wiki Evaluation report RADAR repository	pathway should be promoted by offering academic credit Student champions should be recruited across all academics levels Formal external accreditation for training is not essential to the scheme and can be optional The commissioned projects should be defined as early as possible so students can start working on them from the outset to reduce attrition A formal mentor role should exist so as to facilitate the commissioning work and induct the students The completed projects should be used to showcase the outputs, raise awareness and attract further interest	The commissioned student/staff partnership work should be optimised to fit the student academic schedule and have defined objectives and milestones e-Pioneers should be supported by a mentor/coach that can help them understand what is required and facilitate the required role reversal so as they become equal partners with staff Student-staff partnerships may be a viable mechanism for enhancing other graduate attributes than digital literacies
University of the Arts London (DIAL)	Ensure students and staff understand the relevance of digital literacies to their own professional and personal lives	Online resources Digital Literacy model Emerging definitions of	Balance institutional and	Encourage more voluntary support and research from students Integrate digital literacy

	Provide training and development for a diverse audience Staff development in the use of technology Sustain change cost effectively	digital literacy at UAL A prototype for digital information literacy Digital literacy attributes for employability Video resources Workshops and teaching templates Project Blog Case studies Open Scholarship policy Training programme Developing badges model and designs Baseline report	third-party digital tools Balance online digital and face-to-face teaching Staff and students need training, guidance and support in digital literacy Students understand digital literacy best within the context of professional practice The use of student ambassadors is advantageous in raising awareness Staff and students should work collaboratively Defining digital literacies needs to be an agile, continuous process Consider if digital literacy development should be delivered inside or outside the curriculum Students should be informed about digital literacy development explicitly	development into programmes Staff and student training programmes Recognise the importance of digital skills across the university Acknowledge the development of digital skills Encourage and support open education initiatives such as creation of OERs

Worcester College of Technology (WORDLE)	Measuring the development of digital literacy skills development Gaps identified in student information literacy Developing a digital literacy framework and mapping the digital literacy skills of student s and teachers Develop a structured course design approach enabling personally accountable learning and enhances student engagement Develop a training programme for students and teachers that aligned the curriculum to digital literacy developmental needs of the students Adopt a method of acknowledging quality designs in the curriculum	Project Wiki Baseline report Case studies Process documentation Development templates	There was evidence that the developmental approach was beneficial to teachers Established ways of monitoring progress and acknowledging achievement by issuing certificates of completion to students Established ways for measuring the impact of the development process Active input from all stakeholders and especially management is a requirement Course outcomes should be measured, monitored and analysed utilising robust statistical processes There should be a review approach for revising the course material to address feedback Quality assurance guidelines and policy should be established	Digital literacy skills could be embedded into workshops during student induction Extend staff CPD programme Establish a digital literacy strategy Share good practice and resources by making the training material widely available

Grwp Llandrillo Menai (PADDLE)	Produce digital literacy frameworks customised to leaners, teachers, managers and support staff Create communities of practice for students and staff Embed digital literacy in the curriculum including assessment Ascertain digital literacy development as a strategic goal across the partner institutions	Competence frameworks Case studies Videos Podcasts Support resources	Establish small grants to facilitate staff development and/or provide resources Institutions should allow learners and teachers to engage widely with technologies and systems including those outside their immediate control but establish an inclusive environment and appropriate usage policies to safeguard the learner's wellbeing Digital literacy is developed when focusing on the use of technologies and not on systems E-safety is of particular importance in FE	Acknowledge the need for change in practice and plan Communicate good practice and support other institutions Facilitate knowledge transfer Capture evidence of impact to inform policy
University of Greenwich (Digital Literacies in Transition)	Establish a curriculum design and approval process to support the integration of DL Identify Digital Literacy activities in the curriculum Enhance understanding (miss-alignment between staff and students)	Project website Baseline review and resources Benefits Realisation Camel Critical Digital Literacy model and resources	Embedding of DL in the LTAS strategy Launch of Greenwich Connect Integration into the staff	University eLearning strategy Impact on the EDU LTAS, Greenwich Connect as well as other areas all make reference to digital literacy

	Resource and support the integration of technology and the application of that technology Employer/professional engagement in the curriculum	Interdisciplinary Research Group Transition work Change Agent Network Student workshop series Viewpoints Work - Developing DL in the Curriculum iPads and digital literacies Employability resources	development portfolio iPads in HE HEI-Flyers	
Exeter University (CASCADE)	The project focused on: a) research-rich teaching, b) academic staff engagement, c) researcher development, d) students as agents of change and a number of other learning and teaching initiatives Develop the digital literacies of learners and teaching/research staff by focusing on the use of digital technologies for enquiry-based learning	Cascade project web site Cascade project blog ExeterCASCADE youtube channel Exetercascade delicious stacks Twitter: @exetercascade	Developing personal 'digital literacy' Challenges identified for students and staff in becoming digitally literate Developing digital literacy as an aspect of a discipline or department Challenges to the development of digitally literate disciplines and departments Developing digital literacy at an institutional level PGRs as change agents	Post-graduate students and teaching assistants identified as suitable champions for digital literacy development because of their visibility, relative influence and increased engagement opportunities for mentorship related to other teaching/research responsibilities

Plymouth University (SEEDPoD)	A realisation that digital literacy has an impact on all staff and students as well as institutional practice. Integrating more efficiently institutional strategies into curriculum development, validation and review and ensure the consistency of technology use across the curriculum. Investigating the digital literacy needs of a number of stakeholders and identify suitable interventions that could facilitate the adoption of good practices in developing digital literacy.	SEEDPoD Project Website Guide to Digital Literacies Digital Tools For Busy Academics 'Talking about iPads' 90 minute digital literacy workshop Postgraduate Researcher Digital Skills Video Case Studies	Disciplinary differences in developing digital literacy is an area of interest but these are not easy to define Auditing digital literacy as evidence of employability should identify what learners need to develop further but it should also recognise their existing skills Defining digital literacy is a complex task affected by changes in technology and the subjective interpretations of the individuals and or disciplines Senior stakeholder buy-in is key Digital literacy should be embed in strategies and plans from a strategic perspective Use of pre-existing networks and communities of practice increases the chances of success and future sustainability	A number of project outputs have been shared on the UPlaCe repository to sustain impact. These were maintained by the teaching and learning development department Community promotion, staff development and TEL sessions. Embed within PGCAP Embed the recommendation s and the new curriculum design to teaching and learning development processes and review annually Ongoing promotion of topics related to digital literacy

Appendix 3 - Ethics Approval

24 September 2013

Anglia Ruskin University

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CB1 1PT

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Georgios Evangelinos
Faculty of Health, Social Care and Education

Dear Georgios,

Re: Application for Ethical Approval

Project Number: 12/091
Project Title: Investigating Digital Competences in Nursing Education

Principal Investigator: Georgios Evangelinos

Thank you for resubmitting your documentation in respect of your application for ethical approval. This has been reviewed by the Chair of the Faculty (of Health, Social Care & Education) Research Ethics Panel (FREP) in advance of the next scheduled meeting in October.

I am pleased to inform you that your research proposal has been approved by the Faculty Research Ethics Panel under the terms of Anglia Ruskin University's *Policy and Code of Practice for the Conduct of Research with Human Participants*. Approval is for a period of three years from 24 September 2013.

It is your responsibility to ensure that you comply with Anglia Ruskin University's Policy and Code of Practice for Research with Human Participants and specifically:

- The procedure for submitting substantial amendments to the committee, should there be any changes to your research. You cannot implement these changes until you have received approval from FREP for them.
- The procedure for reporting adverse events and incidents.
- The Data Protection Act (1998) and any other legislation relevant to your research. You must also ensure that you are aware of any emerging legislation relating to your research and make any changes to your study (which you will need to obtain ethical approval for) to comply with this.
- Obtaining any further ethical approval required from the organisation or country (if not carrying out research in the UK) where you will be carrying the research out. Please ensure that you send the FREP Secretary copies of this documentation.

- Any laws of the country where you are carrying the research out (if these conflict with any aspects of the ethical approval given, please notify FREP prior to starting the research).

- Any professional codes of conduct relating to research or research or requirements from your funding body (please note that for externally funded research, a project risk assessment must have been carried out prior to starting the research).

- Notifying the FREP Secretary when your study has ended.

Information about the above can be obtained on our website at:

http://web.anglia.ac.uk/anet/rdcs/ethics/index.phtml/

Please also note that your research may be subject to random monitoring by the committee.

Please be advised that, if your research has not been completed within three years, you will need to apply to our Faculty Research Ethics Panel for an extension of ethics approval prior to the date your approval expires. The procedure for this can also be found on the above website.

Should you have any queries, please do not hesitate to contact me. May I wish you the best of luck with your research.

Yours sincerely

Dr Leslie Gelling
For the Faculty (of Health, Social Care & Education) Research Ethics Panel

cc:

Debbie Holley (Supervisor)
Beverley Pascoe (RESC Secretary)

Appendix 4 - Ethics Consent Form

Participant Consent Form

Project Title: Investigating Digital Competences in Health Education

NAME OF PARTICIPANT:	
CONTACT DETAILS:	

Main investigator and contact details:

Please read the following statements carefully and then sign at the bottom:

1. I agree to take part in the above research. I have read the Participant Information Sheet which is attached to this form. I understand what my role will be in this research, and all my questions have been answered to my satisfaction.
2. I understand that I am free to withdraw from the research at any time, for any reason and without prejudice.
3. I have been informed that the confidentiality of the information I provide will be safeguarded.
4. I am free to ask any questions at any time before and during the study.
5. I have been provided with a copy of this form and the Participant Information Sheet.

Data Protection: I agree to the University processing personal data which I have supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me.

Name of participant (print): _______________________________________

Signed: _______________________________________ Date: ____________________

YOU WILL BE GIVEN A COPY OF THIS FORM TO KEEP

If you wish to withdraw from the research, please complete the form below and return to the main investigator named above.

NAME OF PARTICIPANT:	
Title of Project:	

I WISH TO WITHDRAW FROM THIS STUDY

Signed: _______________________________________ Date: ____________________

Appendix 5 - Ethics Participant Information Sheet Students

Title of project

Investigating Digital Competences in Health Education

Purpose and value of study

Nearly nine out of ten graduate jobs demand competences and skills in information technology. Nowadays, employers seek versatility, interactivity and reasoning in the use of digital ecosystems. The needed set of skills and competences can broadly be described as digital competence. While digital technology ownership and use is increasingly widespread among university students, it is primarily used for personal communications or other leisure activities, and scarcely in support of learning.

Invitation to participate

This project will help us to gain an insight on your perspectives so as to shape the future of learning, teaching and assessing across the institution. It will direct us on how to help you develop your digital competences, embed them into your curriculum and improve your student experience. For these reasons we value your ideas and involvement in the project.

Who is organising the research

The primary researcher for this project is George Evangelinos, a Learning Technologist with the faculty of Health and Social Care and Education. The research, part of a doctoral research at the University, aims to explore the boundaries of how digital competences are understood within the discipline of nursing.

What will happen to the results of the study

The results of the study will be disseminated to the wider research community; anonymity and confidentiality will certainly be maintained at all times and that the research will be conducted ethically under the scrutiny of the university's ethical committee.

Source of funding for the research

The research is organised by the Faculty of Health Social Care and Education at Anglia Ruskin University as part of its on-going commitment to deliver an up-to-date curriculum that meets and exceeds the needs of students; the target is to educate professionals that will excel in their professional careers.

Contact for further information

Mail:

Email:

Telephone:

Why you have been invited to take part

You are invited to participate because, as a student, you are an integral part and stakeholder in nursing education.

Whether you can refuse to take part

You can refuse to take part, without any penalty and without having to justify your decision, just by informing the research team.

Whether you can withdraw at any time, and how

You can withdraw at any time, without any penalty and without having to justify your decision, just by informing the research team by writing, emailing or calling us. The full contact details of the research team can be found at the bottom of this page.

What will happen if you agree to take part (brief description of procedures/tests)

If you decide to take part in the study, we will contact you to make arrangements for an interview to take place. The interview will take place on campus at a time convenient to you and it is scheduled to last for no more than 90 minutes.

Whether there are any risks involved (e.g. side effects from taking part) and if so what will be done to ensure your wellbeing/safety

The risks to the participants are thought to be minimal as every care will be taken to ensure safety and welfare. The interviews will take place on campus or other university grounds where security and first aid are always available on call.

Agreement to participate in this research should not compromise your legal rights should something go wrong

Please note that consent to participating in this research would not compromise your legal rights should anything went wrong.

Whether there are any special precautions you must take before, during or after taking part in the study

There are no special precautions.

What will happen to any information/data/samples that are collected from you

Files in print such as interview schedules/questionnaires/notes will be filed and kept as evidence in a secure (locked) drawer at a secure office space, with security during day-time and an alarm system outside office hours. The laptop computer where the audio recordings of the interviews will be stored and analysed and the electronic questionnaire system (survey monkey) are encrypted and password protected.

Whether there are any benefits from taking part

The digital literacy characteristics, pertinent to the profession, will be extrapolated from the views of all stakeholders involved (students, academic and administrative staff) and inform the institution on how to best develop the relevant qualities and skills needed from graduates by embedding digital competences into the curriculum.

How your participation in the project will be kept confidential

The research data (interview audio recordings, self-assessment questionnaire) will be stored securely and processed according to the university's ethical procedures and the Data Protection Act. Dissemination will be anonymous and strictly confidential; in no way will you be personally identified in any correspondence or dissemination of research data to 3rd parties.

For more information or any other questions about this project please contact:

YOU WILL BE GIVEN A COPY OF THIS TO KEEP

TOGETHER WITH A COPY OF YOUR CONSENT FORM

Appendix 6 - Participant Information Staff

Title of project

Investigating Digital Competences in Nursing Education

Purpose and value of study

Nearly nine out of ten graduate jobs demand competences and skills in information technology, with employers seeking versatility, interactivity and reasoning in the use of digital ecosystems. This set of skills and competences can be broadly described as digital competence. While digital technology ownership and use is increasingly widespread among university students, it is primarily used for personal communications and other leisure activities but scarcely in support of learning.

Invitation to participate

We value your ideas and involvement in this project as it will help us to gain an insight of your perspectives on how we can best develop your digital competences by embedding them into the curriculum and improving your student experience. It is a great opportunity for you to help shape the future of learning, teaching and assessment across the institution.

Who is organising the research

The research, part of my doctoral research at the University, aims to explore the boundaries of how digital competences are understood within the discipline of nursing by studying your views.

What will happen to the results of the study

The results of the study will be disseminated to the wider research community ensuring that anonymity and confidentiality are maintained at all times and that the research is conducted ethically under the scrutiny of the university's ethical committee.

Source of funding for the research

The research is organised by the Faculty of Health Social Care and Education at Anglia Ruskin University as part of its on-going commitment to deliver an up-to-date curriculum that meets and exceeds the needs of students and educate professionals that excel in their professional careers.

Contact for further information

Mail:

Email:

Telephone:

Why you have been invited to take part

You are invited to participate in this research project as you are part of one of the two major stakeholder groups in nursing education a student or academic/administrative member of staff.

Whether you can refuse to take part

You can refuse to take part, without any penalty and without having to justify your decision, just by informing the research team.

Whether you can withdraw at any time, and how

You can withdraw at any time, without any penalty and without having to justify your decision, just by informing the research team.

What will happen if you agree to take part (brief description of procedures/tests)

If you decide to take part in the study, we will contact you to make arrangements for an interview to take place. The interview will take place on campus at a time convenient to you and it is scheduled to last for no more than 90 minutes.

Whether there are any risks involved (e.g. side effects from taking part) and if so what will be done to ensure your wellbeing/safety

The risks to the participants are thought to be minimal as every care will be taken to ensure your safety and welfare. The interviews will take place on campus or other university grounds where security and first aid are always available on call.

Agreement to participate in this research should not compromise your legal rights should something go wrong

Please note that consent to participating in this research would not compromise your legal rights should anything went wrong.

Whether there are any special precautions you must take before, during or after taking part in the study

There are no special precautions.

What will happen to any information/data/samples that are collected from you

Files in print such as interview schedules/questionnaires/notes will be filed and kept as evidence in a secure-locked drawer at a secure office space with security during day-time and an alarm system outside office hours. The laptop computer where the audio recordings of the interviews will be stored and analysed and the electronic questionnaire system (survey monkey) are encrypted and password protected.

Whether there are any benefits from taking part

The digital literacy characteristics, pertinent to the profession, will be extrapolated from the views of all stakeholders involved (students, academic and administrative staff) and inform the institution on how to best develop the relevant qualities and skills needed from graduates by embedding digital competences into the curriculum.

How your participation in the project will be kept confidential

The research data (interview audio recordings, self-assessment questionnaire) will be stored securely and processed according to the university's ethical procedures and the Data Protection Act. Dissemination will be anonymous and strictly confidential; in no way will you be personally identified in any correspondence or dissemination of research data to 3rd parties.

For more information or any other questions about this project please contact:

YOU WILL BE GIVEN A COPY OF THIS TO KEEP,

TOGETHER WITH A COPY OF YOUR CONSENT FORM

Appendix 7 - Ethics Risk Assessment

Project Risk Assessment

Before attempting this Risk Assessment, please refer to 'Project Risk Assessment Guidance' on the Research, Development & Commercial Services ANET web page for guidance in describing risks and assessing their impact and likelihood. Guidance

Risk ID	Description	Impact Score 1 - 4	Likeli -hood Score 1 - 5	Overall Risk Rating 1 - 20	Traffic light action indicator	Risk Management Action Plan **12 - 20 (Red): action within one month;** **8 - 11 (Amber): action a single amber within three months, and multiple ambers within one month;** **1 - 5 (Green): continue to monitor.** **Consider the management plan for all high impact risks (whatever their overall risk rating) very carefully.**
1	There is a risk that: Key decision makers are not available Caused by: Availability of key decision makers at critical points Resulting in: Delays in the project	1	3	3		Low Risk. Early communication will decrease likelihood.
2	There is a risk that: I will need to use unfamiliar software to analyse the data (SPSS, NVIVO) Caused by: Use of unfamiliar technologies Resulting in: Issues with carrying out data analysis	2	5	10		Intermediate Risk. Training will be sought on SPSS and Nvivo. Once training has been acquired this item will then be downgraded to low risk.
3	There is a risk that: Someone else could be doing the same or similar work and will publish first Caused by: Someone else could be doing the same or similar work and will publish first Resulting in: Issues around originality of research	4	1	4		Low Risk. Initial and on-going literature reviews will ensure that the project is sufficiently original.
4	There is a risk that: Ethical approval will be rejected Caused by: Inappropriate design Resulting in: Delays in the project	2	2	4		Low Risk. The ethical considerations for this project are not terribly complex.
5	There is a risk that: The research data will be lost or accessed without permission Caused by: Loosing laptop Resulting in: Loss of data and unauthorised access	4	1	4		Low Risk: The researcher is very careful and aware of data protection issues and confidentiality. All user accounts are password protected and the equipment is always stored in secure locations.
6	There is a risk that: People being expected to use a new technology and do their jobs in a different way Caused by: Changes in the working practices intrinsic to the project Resulting in: Potential resistance to change	1	5	5		Low Risk: This is a certainty but not necessarily an issue as this is an intrinsic part of this research project as it is primarily based on action research. Consensus will be asked and encouraged via various communications and support will be given. The aims of the project tie into the institution's Corporate Plan and Learning and Teaching strategies.
7	There is a risk that: Participants require extra support Caused by: Changes intrinsic to the research project Resulting in: Participants require extra support	1	5	5		Low Risk: Extra support will be put in place by the researcher as he has a dual role of staff / researcher.
8	There is a risk that: People required to commit resources to my project Caused by: Changes intrinsic to the research project Resulting in: Time resource	1	5	5		Low Risk: This will be managed at a higher level (managerial) level as the outcomes of the project will benefit the student experience and increase employability thus meeting wider university targets.
9	There is a risk that: There are change in funding model Caused by: University policy Resulting in: Funding being reduced or not being available	4	1	4		Low Risk: If this happens alternative funding may become available.
10	There is a risk that: There is a change in legislation or institutional policy Caused by: External environment or institutional policy Resulting in: Change in strategic priorities	4	1	4		Low Risk: This is extremely unlikely as the strategic direction of external organisations and internally seem to support this type of research work.
11	There is a risk that: Physical risks from conducting off-site interviews Caused by: Participants or interviewees could become upset by interview and suffer psychological effects and become a threat to the researcher Resulting in: Physical threat the researcher	4	1	4		Low Risk: Unlikely but a safety protocol has been established. The researcher will contact a nominated colleague when they arrive at the interview location and inform them of who they are with. Once the interview has been completed, the researcher will contact their nominated colleague at an agreed time to let them know they have left safely.
12	There is a risk that: Interviewees could be upset by interview or exposure to data Caused by: Exposure to data or emotional response during/after the interview Resulting in: Interviewees could become upset	4	1	4		Upon arrival, explain the researcher's role and the conditions of confidentiality to the interviewee(s) and offer them the opportunity to ask questions. Adopt a friendly and professional manner when conducting interviews but be careful not to be over-familiar. Debrief the participants after the interview so as to ensure their psychological welfare.
13	There is a risk that: Caused by: Resulting in:			0		
14	There is a risk that: Caused by: Resulting in:			0		
15	There is a risk that: Caused by: Resulting in:			0		
		Nr of Red Risks		0		**This risk assessment is valid:**
		Nr of Amber Risks		1		**Date of assessment (dd/mm/yyyy):** 12/05/2013
		Nr of Green Risks		11		

Appendix 8 - Risk Assessment

Project Risk Assessment – checklist for the risk assessor

Section A - These are generic areas which should be considered when compiling a risk assessment. A project is unlikely to contain risks associated with every item and you may well identify alternative or additional issues for your project.

	Included in my risk assessment? ***(tick as appropriate)***	
Item for consideration	**Yes**	**No or N/A**
Risks arising from the project plan. *Examples:* • Availability of key decision makers at critical points • Decisions that involve more than one team or department • Resources outside your direct control, especially staff • Reliance on specialist suppliers • Any component of the plan based on assumption rather than fact • Use of unfamiliar technologies • Other….	Yes N/A N/A N/A N/A Yes	Yes N/A N/A N/A N/A Yes
Risks particularly relevant to research projects. *Examples:* • Recruitment and retention of suitable research staff • Project costing adjusted to fit available funds rather than likely true cost • The possibility that someone else could be doing the same or similar work and will publish first • Space and facilities for the research activity • Ethical issues and approval processes • Data Protection requirements • Funders rules about withholding or clawing back grants • Other….	N/A N/A Yes N/A Yes Yes N/A	N/A N/A Yes N/A Yes Yes N/A
Risks associated with wider group of stakeholders. *Examples*: • People being expected to use a new technology and/or do their jobs in a different way • People requiring re-training • People required to commit resources to my project • Participants in my research • Other….	Yes Yes Yes Yes	Yes Yes Yes Yes

Appendix 9 - DigComp$_{v0}$ Floor/Ceiling No Response

Digital Literacy Areas	Respondents	No Respondents	% of Min	% of Max	% of NR
DLA1 - General knowledge and functional skills					
I am able to use a digital device, which may be one of many types (e.g. Desktop PC, Laptop, Tablet, Smart phone).	102	0	0%	63%	0%
I possess general computer skills (typing, using computers, getting into a new programme).	102	0	0%	66%	0%
I understand the difference between hardware and software.	102	0	3%	39%	0%
I am familiar with the meaning of terms commonly used in user manuals for the operation of hardware and the installation and configuration of software.	102	1	0%	21%	1%
I know about the existence of various operating systems.	102	0	1%	21%	0%
DLA2 - Use in everyday life					
I am able to download and access different information types from the Internet.	102	0	0%	60%	0%
I am able to use at least office applications (or other work related applications) to edit and create content (text, numeric, images).	102	0	0%	60%	0%
I am able to search, collect, process, evaluate, share, store data and information using various devices, applications, cloud services.	102	0	0%	39%	0%
I can conduct transactions online (e.g. pay bills, apply for a job, submit tax declaration, complete online forms, book a hotel, interact with government or local services, shop online, etc.).	102	0	0%	70%	0%

Digital Literacy Areas	Respondents	No Respondents	% of Min	% of Max	% of NR
I consult digital resources as a matter of routine across various aspects of life (news, health, sports, travel, entertainment, etc.).	102	0	0%	61%	0%
DLA3 - Specialised and advanced competence for work and creative expression					
I use technology to improve the quality of my work.	102	0	0%	50%	0%
I have mastered specialised digital skills needed by his/her area of work.	102	4	1%	15%	4%
I am able to create knowledge representations (e.g. mind maps, diagrams) using digital media.	102	0	2%	24%	0%
I am able to use a variety of media to express myself creatively (text, images, audio, and movie).	102	0	0%	29%	0%
I am able to remix different existing content into something new.	102	2	2%	11%	2%
DLA4 - Technology mediated communication and collaboration					
I am able to communicate through ICT (e.g. email, instant messaging, video conferencing.).	102	0	0%	55%	0%
I am able to use social media and participative technology.	102	0	0%	51%	0%
I am able to use digital media to be part of a community.	102	0	0%	40%	0%
I am able to take advantage of digital technology to cooperate and take part in networks and networked learning for personal or professional purposes.	102	0	0%	32%	0%
I can use ICT for team work (collaboration, co-construction of content); to work at a distance.	102	2	1%	31%	2%
DLA5 - Information processing and management					

Digital Literacy Areas	Respondents	No Respondents	% of Min	% of Max	% of NR
I am able to judge the validity of content found on the Internet, how to find appropriate material, and what sources can be trusted.	102	0	1%	30%	0%
I am able to compare and contrast information from diverse sources (triangulate information) before it is used in a knowledge-making process.	102	1	0%	17%	1%
I am able to gather relevant digital information, e.g. other users' experiences, and to assess the quality of goods based on that information.	102	1	0%	22%	1%
I can integrate, compare and put together different types of information related to multimodal content.	102	4	2%	7%	4%
I am able to structure, classify, and organise digital information/content according to a certain classification scheme or genre.	102	3	3%	9%	3%
DLA6 - Privacy and security					
I understand the risks associated with online use and encounters with unknown persons.	102	0	63%	0%	0%
I am aware of privacy issues when using Internet/mobile Internet and I am able to act prudently.	102	0	59%	0%	0%
I am able to protect myself from threats of the digital world (fraud, malware, viruses etc.).	102	0	35%	0%	0%
I understand the risk of identity theft and other credentials' thefts and I am able to take steps to mitigate risk.	102	0	43%	0%	0%
I know that many interactive services use information about me to filter in commercial messages in more or less explicit manners.	102	0	41%	0%	0%

Digital Literacy Areas	Respondents	No Respondents	% of Min	% of Max	% of NR
DLA7 - Legal and ethical aspects					
I am able to communicate and collaborate with others in line with codes of conduct appropriate to the context.	102	0	1%	53%	0%
I am considerate towards legal and ethical principles of use and publication of information.	102	0	1%	61%	0%
I understand copyright and licence rules.	102	0	1%	49%	0%
I am aware of the different ways of licensing intellectual property production and I understand the differences between using copyright, public domain, copyleft and/or creative commons licenses.	102	0	2%	24%	0%
I have an advanced sense of suitable behaviour, finely tuned to media context, audience and legal provisions.	102	1	1%	30%	1%
DLA8 - Balanced attitude towards technology					
I have a positive but realistic attitude towards the benefits and risks associated with information technologies.	102	0	0%	47%	0%
I understand that the digital environment we are facing can make things better or worse - it all depends on how we are using it and what rules we find for it.	102	1	0%	59%	1%
I am able to assess and reduce/avoid technology related threats to my health.	102	4	0%	37%	4%
I use digital media and tools without fear, always aware that digital enablers should serve the human being to have a better life (and not the opposite).	102	1	0%	38%	1%
I see digital media as enablers rather than inhibitors of choice and action.	102	7	0%	32%	7%

Digital Literacy Areas	Respondents	No Respondents	% of Min	% of Max	% of NR
DLA9 - Understanding and awareness of role of ICT in society					
I understand the role of ICT in everyday life, in social life and at work.	102	0	0%	59%	0%
I understand the wider context of digital tools in a 'digital age' characterised by globalisation and networks.	102	2	0%	42%	2%
I am aware of the general trends within new media even if I do not use them.	102	0	0%	40%	0%
I understand where ICT comes from, who develops it and for what purposes.	102	0	0%	24%	0%
I am aware of environmental issues related to the use of digital technologies.	102	0	1%	22%	0%
DLA10 - Learning about and with digital technologies					
I am able to use digital media to learn (develop myself).	102	0	0%	46%	0%
I am able to use a digital environment for lifelong learning (formal or informal).	102	0	0%	42%	0%
I can use ICT resources to safely expand my own knowledge and connect to the world around me.	102	0	0%	46%	0%
I am able to learn how to work with any new digital technology by trying it out, and using its internal guidance and help.	102	0	0%	34%	0%
I am able to adapt smoothly to new technology and to integrate technology into my environment.	102	0	0%	31%	0%

Digital Literacy Areas	Respondents	No Respondents	% of Min	% of Max	% of NR
DLA11 - Informed decisions on appropriate digital technologies					
I understand the potential of digital devices and resources for my work.	102	0	0%	39%	0%
I know the range of things that can be done using ICT/Internet.	102	0	0%	29%	0%
I am able to use digital services without being completely dependent on them (or: helpless without).	102	0	0%	35%	0%
I choose the most appropriate technologies according to the task.	102	0	0%	25%	0%
I am aware of the most relevant or popular digital technologies used by others (e.g. peers, reputed experts).	102	0	1%	26%	0%
DLA12 - Seamless use demonstrating self-efficacy					
I am able to arrange and develop my personal working environment as an effective and reliable system.	102	0	0%	24%	0%
I can use different ICT in a way that helps to achieve certain results more quickly, or more easily, or to achieve better results.	102	0	0%	31%	0%
I can access technology and use it without realising that I am actually using it.	102	4	1%	26%	4%
I know how to use digital equipment cost-efficiently and also time efficiently.	102	1	0%	21%	1%
I can solve a theoretical or practical problem, of individual or collective interest, through or with the support of digital tools.	102	1	0%	25%	1%

Appendix 10 - Digital Literacy Areas Spearman Correlation Coefficient DigComp$_{v0}$

Digital Literacy Areas Spearman Correlation Coefficient DigComp$_{v0}$ (pairs of)											
DL Area 1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Spearman	0.723221	0.637848	0.466739	0.487218	-0.47062	0.331789	0.522536	0.560954	0.570476	0.577823	0.545866
Alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
rho	0.723221	0.637848	0.466739	0.487218	-0.47062	0.331789	0.522536	0.560954	0.570476	0.577823	0.545866
t-stat	9.654802	7.635616	4.86561	5.143737	-4.91751	3.242627	5.6503	6.24722	6.403802	6.527208	6.006446
p-value	2.56E-15	3.05E-11	5.19E-06	1.7E-06	4.23E-06	0.001693	2.09E-07	1.59E-08	8E-09	4.63E-09	4.55E-08
	DL Area 2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Spearman	0.653502	0.71325	0.535914	-0.55181	0.405614	0.645719	0.565633	0.724453	0.675365	0.588384
	Alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	rho	0.653502	0.71325	0.535914	-0.55181	0.405614	0.645719	0.565633	0.724453	0.675365	0.588384
	t-stat	7.959825	9.381869	5.852229	-6.10021	4.091237	7.796534	6.323687	9.689393	8.442977	6.708826
	p-value	6.82E-12	9.11E-15	8.84E-08	3.03E-08	9.72E-05	1.45E-11	1.14E-08	2.18E-15	7.24E-13	2.06E-09

		DL Area 3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		Spearman	0.699508	0.655733	-0.44096	0.549425	0.644257	0.713981	0.787275	0.783652	0.768083
		Alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
		rho	0.699508	0.655733	-0.44096	0.549425	0.644257	0.713981	0.787275	0.783652	0.768083
		t-stat	9.024529	8.007443	-4.52967	6.06246	7.766335	9.40147	11.77148	11.63059	11.0586
		p-value	4.82E-14	5.47E-12	1.91E-05	3.57E-08	1.67E-11	8.31E-15	1.54E-19	2.91E-19	3.91E-18
			DL Area 4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
			Spearman	0.690935	-0.54944	0.426771	0.616908	0.628259	0.7475	0.671635	0.734843
			Alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
			rho	0.690935	-0.54944	0.426771	0.616908	0.628259	0.7475	0.671635	0.734843
			t-stat	8.811674	-6.06263	4.350739	7.226628	7.445031	10.37485	8.35782	9.989005
			p-value	1.3E-13	3.57E-08	3.76E-05	1.98E-10	7.31E-11	9.06E-17	1.08E-12	5.41E-16

				DL Area 5	**6**	**7**	**8**	**9**	**10**	**11**	**12**
				Spearman	-0.4619	0.570597	0.6291	0.6411	0.620073	0.664828	0.694523
				Alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05
				rho	-0.4619	0.570597	0.6291	0.6411	0.620073	0.664828	0.694523
				t-stat	-4.80134	6.405806	7.461516	7.701606	7.286775	8.205399	8.89986
				p-value	6.69E-06	7.93E-09	6.78E-11	2.25E-11	1.51E-10	2.18E-12	8.61E-14
					DL Area 6	**7**	**8**	**9**	**10**	**11**	**12**
					Spearman	-0.48038	-0.59194	-0.55284	-0.55915	-0.53525	-0.39702
					Alpha	0.05	0.05	0.05	0.05	0.05	0.05
					rho	-0.48038	-0.59194	-0.55284	-0.55915	-0.53525	-0.39702
					t-stat	-5.0497	-6.77107	-6.11664	-6.21797	-5.84208	-3.98807
					p-value	2.49E-06	1.56E-09	2.82E-08	1.81E-08	9.23E-08	0.000141

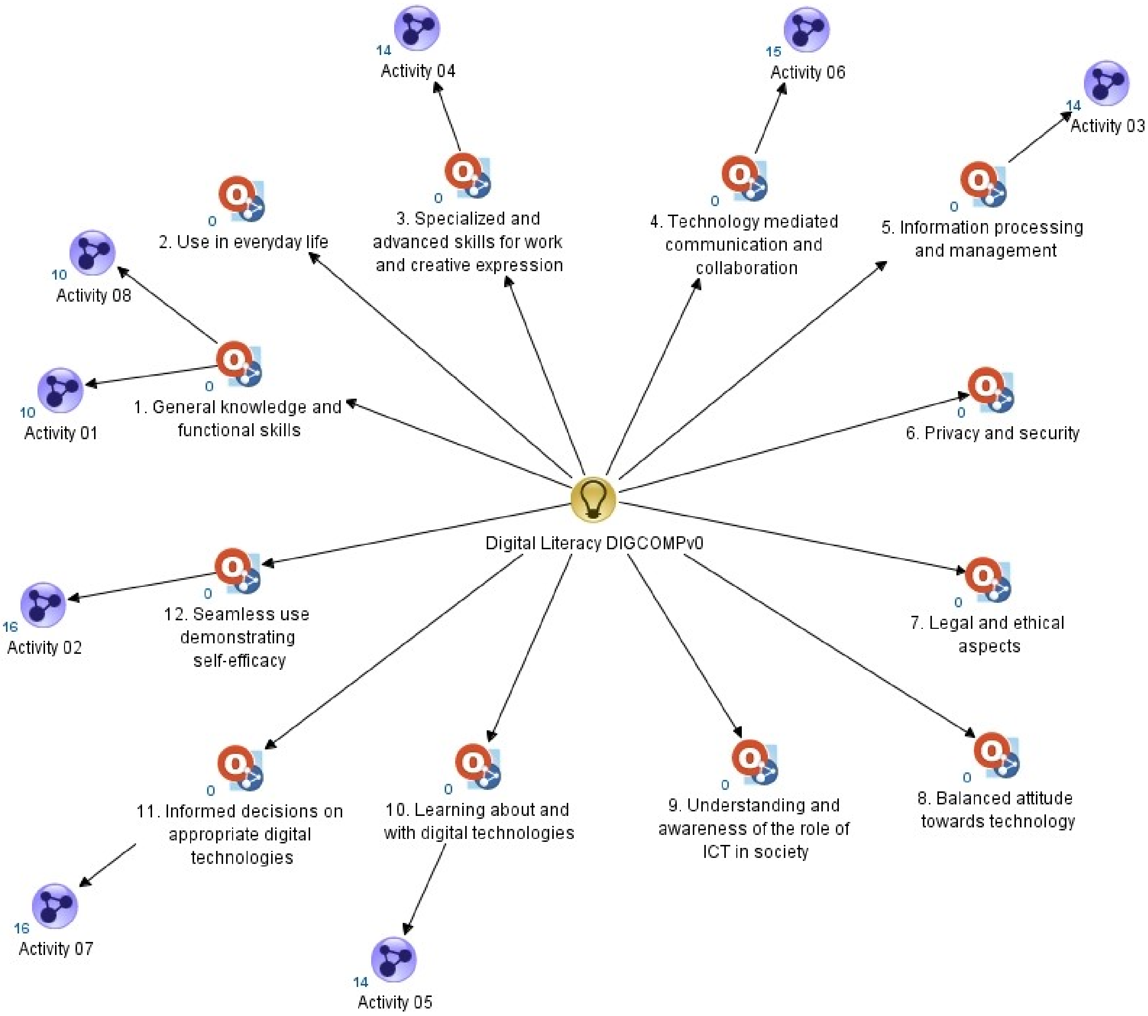
						DL Area 7	**8**	**9**	**10**	**11**	**12**
						Spearman	0.662806	0.620619	0.542877	0.654198	0.569497
						Alpha	0.05	0.05	0.05	0.05	0.05
						rho	0.662806	0.620619	0.542877	0.654198	0.569497
						t-stat	8.160848	7.297201	5.959759	7.97465	6.387526
						p-value	2.69E-12	1.44E-10	5.57E-08	6.37E-12	8.6E-09
							DL Area 8	**9**	**10**	**11**	**12**
							Spearman	0.702037	0.722249	0.663539	0.61881
							Alpha	0.05	0.05	0.05	0.05
							rho	0.702037	0.722249	0.663539	0.61881
							t-stat	9.088739	9.627664	8.176959	7.262709
							p-value	3.57E-14	2.9E-15	2.49E-12	1.68E-10

								DL Area 9	**10**	**11**	**12**
								Spearman	0.647539	0.792459	0.71255
								Alpha	0.05	0.05	0.05
								rho	0.647539	0.792459	0.71255
								t-stat	7.834323	11.9787	9.363163
								p-value	1.22E-11	6.06E-20	9.93E-15
									DL Area 10	**11**	**12**
									Spearman	0.792989	0.734679
									Alpha	0.05	0.05
									rho	0.792989	0.734679
									t-stat	12.00027	9.98417
									p-value	5.5E-20	5.53E-16

										DL Area 11	**12**
										Spearman	0.81423
										Alpha	0.05
										rho	0.81423
										t-stat	12.93074
										p-value	8.88E-22

Appendix 11 - Learning Designs

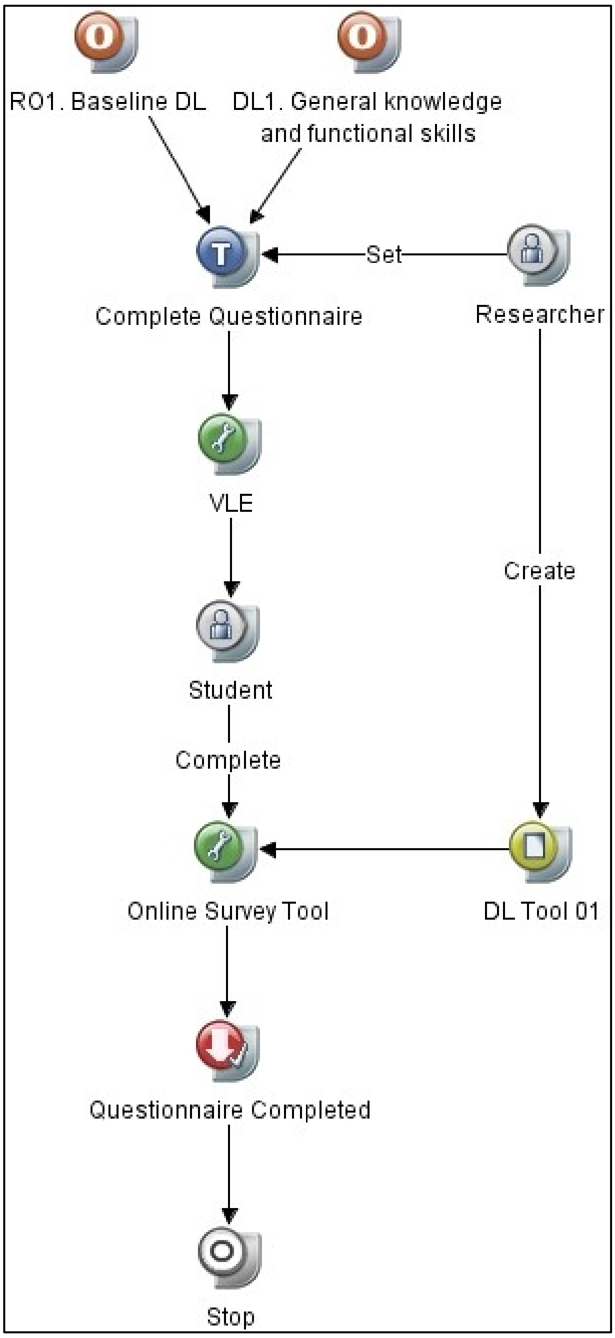
Learning Designs - Online Delivery based on DIGCOMP$_{v0}$



Activity 01 - Investigating Digital Competences in Health Education (DCHE)

Introduction

Myles Danson (a programme manager in Technology Supported Business Change for Joint Information Systems Committee) articulated the need for further research in the areas of digital competences in his presentation 'What Skills do we need for the digital age? The future of the digital administrator'. Modified questions from his conclusions about the areas in which further research is warranted follow; the questions, when translated into research question format are:



- *Are learning practices, expectations and needs of students changing in response to the widespread availability of digital devices, networks and services?*

- *Are practices of academics and academic professionals changing in response to the widespread availability of digital devices, networks and services?*

In an attempt to explore the questions above the research project will focus on proposed digital competence frameworks, currently under development within the Digital Competence project that is run under the auspices of the European Union Directorate General of Education and Culture. The broad areas identified in Anusca Ferrari's framework analysis in 'Digital Competence in Practice: An Analysis of Frameworks' and more recently expanded by José Janssen's and Slavi Stoyanov's 'Online Consultation on Experts' Views on Digital Competence' will be used as a theoretical framework for the research project. Through the examination of how digital competences are understood by students, academics and administrative staff within the Faculty of Health, Social Care and Education at Anglia Ruskin University emergent themes on the digital competence characteristics will be extrapolated, categorised, compared and contrasted. The results will define the basis for further investigations of how the institution can best develop the relevant qualities and skills needed from graduates by nurturing digital competences within the educational provision of the nursing curriculum. Ultimately, the work will help to crystallise appropriate interventions that can inform the strategic planning and support the formulation of policy based on evidence of how to best develop digital competences within the delivery of the nursing curriculum.

The full details for this project and its ethical approval basis can be found here DCNE - PIS Student (ARU Letterhead).pdf.

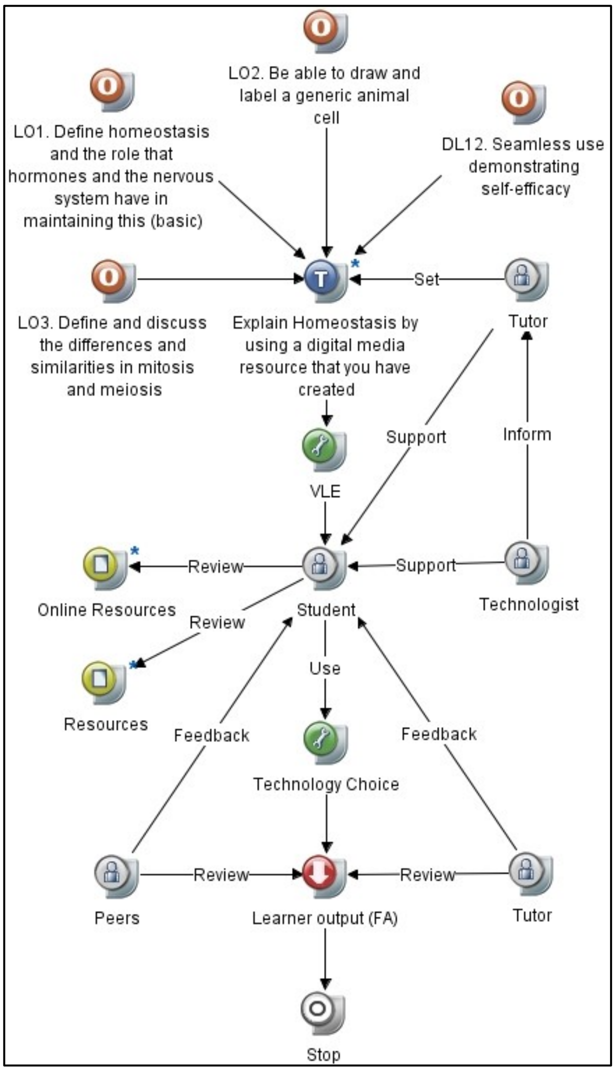
Task

Before you start undertaking the learning activities we would like to collect baseline data (anonymous at your discretion) on your perceived digital competences by asking you to kindly complete the DCNE self-assessment questionnaire. Note that this is not a test and there are no right and wrong answers. Please take the time to consider the options and complete it as accurately as possible as this will help us to build a more precise picture of your digital competence.

Completion

This is your first task and should be completed before you attempt any of the other activities.

Activity 02 - Introduction to the Human Body, Cells Tissues and Homeostasis



Objectives

1. Define homeostasis and the role that hormones and the nervous system have in maintaining this. (basic)
2. Be able to draw and label a generic animal cell
3. Define and discuss the differences and similarities in mitosis and meiosis

Learning Materials

The usual anatomy and physiology textbooks, Coad, Stables Marieb etc.

- Human Homeostasis (Wikipedia)
- Homeostasis (Penn Medicine)
- Homeostasis Song (Mr Parr)
- Homeostasis and How it applies to the Human Body (Professor Knop)
- Human Body Levels of Organization (Professor Knop)
- Introduction to Body Systems (Professor Knop)
- DNA and DNA Replication (Professor Knop)
- Mitosis vs. Meiosis (Thinkwell's Video Biology Course)

Task

Now that you have acquired the required knowledge please attempt to explain to others in your cohort what homeostasis is. You can use a variety of presentation methods such as an electronic presentation (PowerPoint, Prezi, etc.) or a recording of yourself explaining it with or without audio or visual aids. Please try to be creative and do not constrain yourself by your prior presentation experiences as this can be done in a number of ways. The outcome of your work should be an electronic resource that is uploaded on your personal Activities Contributions

Document Library folder. You can also upload the files on the document library repository below for your peers to feedback.

After you review the work of your peers please leave constructive feedback in the discussion board below.

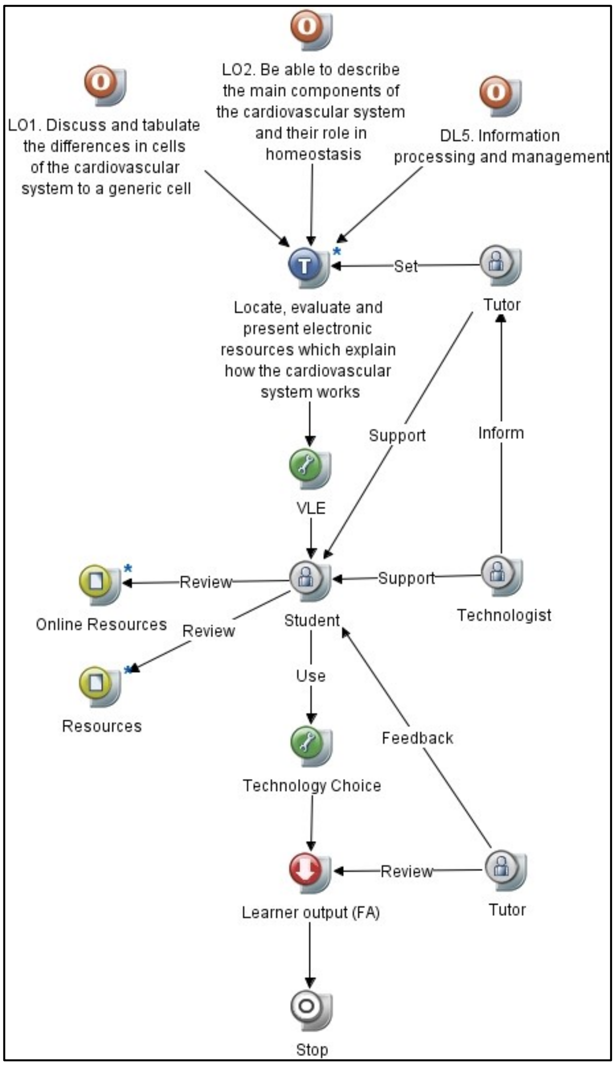
Completion

This activity must be completed by week four.

Activity 03 - Cardiovascular system

Objectives

1. Discuss and tabulate the differences in cells of the cardiovascular system to a generic cell.
2. Be able to describe the main components of the cardiovascular system and their role in homeostasis.



Learning Materials

The usual anatomy and physiology textbooks, Coad, Stables Marieb etc.

- Cardiovascular System (Regina Bailey, About.com Guide)
- Circulatory system (Wikipedia)
- Welcome to Know Your Heart (British Heart Foundation)

Task

Locate, evaluate and present electronic resources which explain how the cardiovascular system works. Please note that although you could focus on a specific area you should try and encompass a broader system approach rather than be too specific. The resources could be addresses of websites, videos, audio, documents or any other electronic resource. The outcome of this activity should be the dissemination of the resources including a short (approximately 150 words) evaluation of the resources. The evaluation should be in terms of credibility of source, applicability to Midwifery, ease of understanding and presentation quality. You can upload your output into your personal Activities Contributions Document Library folder.

Completion

This activity must be completed prior to the taught session on Blood Pressure.

Activity 04 - Renal System

Objectives

1. Describe and tabulate the main differences in cells in the renal system as opposed to a generic cell.
2. Describe how urine is formed and excreted.

Learning Materials

The usual anatomy and physiology textbooks, Coad, Stables Marieb etc.

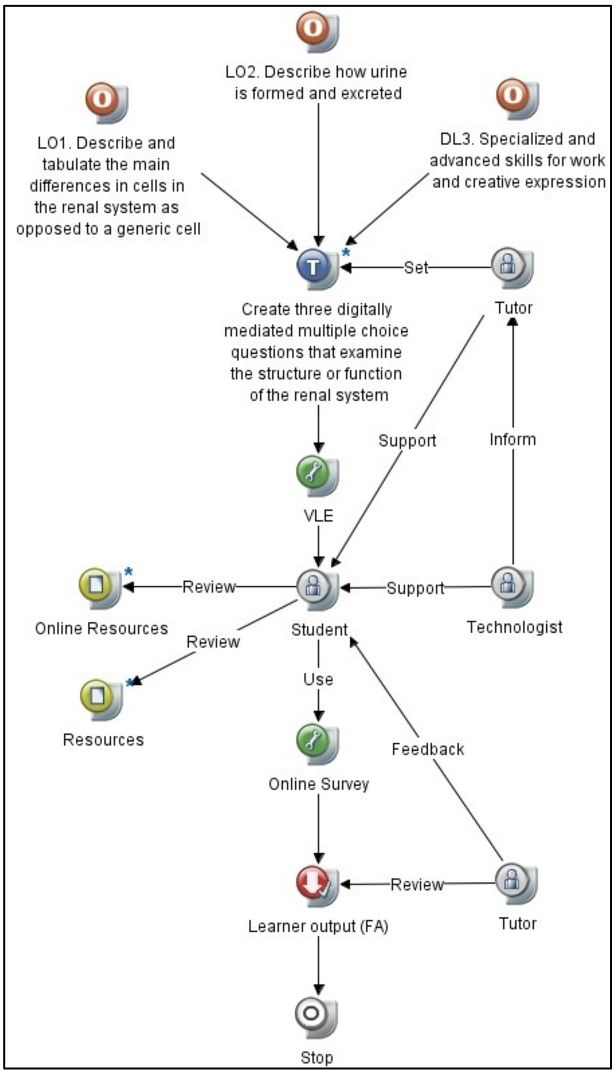
- Earth Physiology (NSBRI)
- Urination (Penn Medicine)
- Renal System (Leicester)
- Human Physiology/The Urinary System (WikiBooks)

Task

Familiarise yourself with the topic and once you feel confident create three multiple choice questions that examine the structure or function of the renal system. The outcome of this activity should be three digitally mediated multiple choice questions facilitated online.

Completion

This activity must be completed prior to the taught session on Blood Pressure.

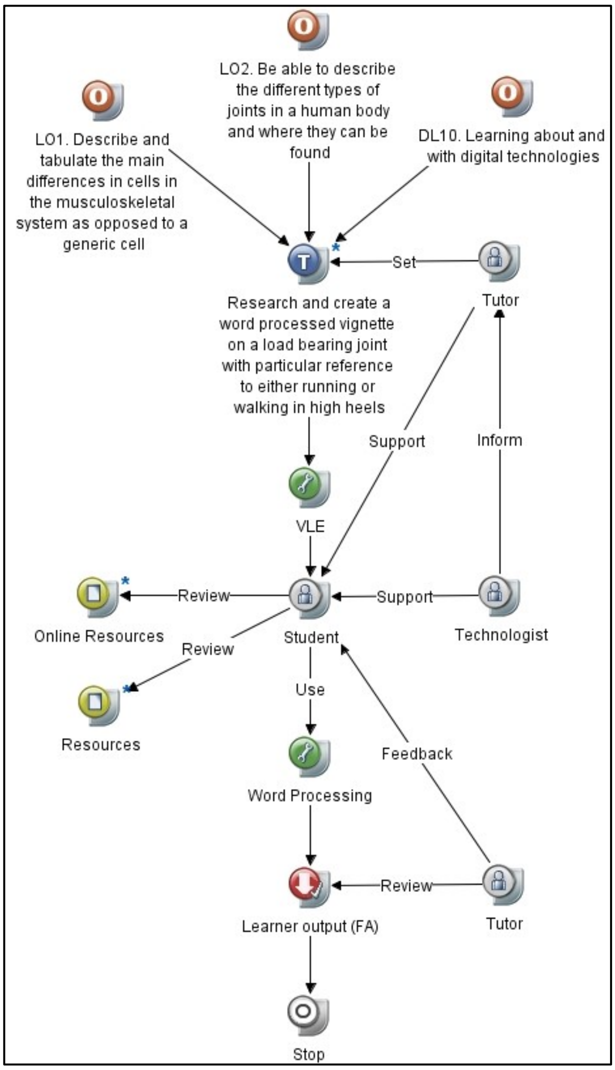


Activity 05 - Musculoskeletal System

Objectives

1. Describe and tabulate the main differences in cells in the musculoskeletal system as opposed to a generic cell.
2. Be able to describe the different types of joints in a human body and where they can be found.

Learning Materials



The usual anatomy and physiology textbooks, Coad, Stables Marieb etc.

- Acute Exercise - How The Body Responds (By Zoe Dickins)
- Basic Skeletal System Structures and Functions (Professor Knop)
- Human musculoskeletal system (Wikipedia)

Task

Acquaint yourself with the topic and then create a vignette on a load bearing joint with particular reference to either running or walking in high heels. The output of this activity should be text (not exceeding 500 words) in the first person (from the point of view of the joint) describing the changes you have to accommodate and should be uploaded on your personal Activities Contributions Document Library folder.

Completion

This activity must be completed prior to the taught session on Maternal Pelvis.

Activity 06 - Gastro Intestinal System

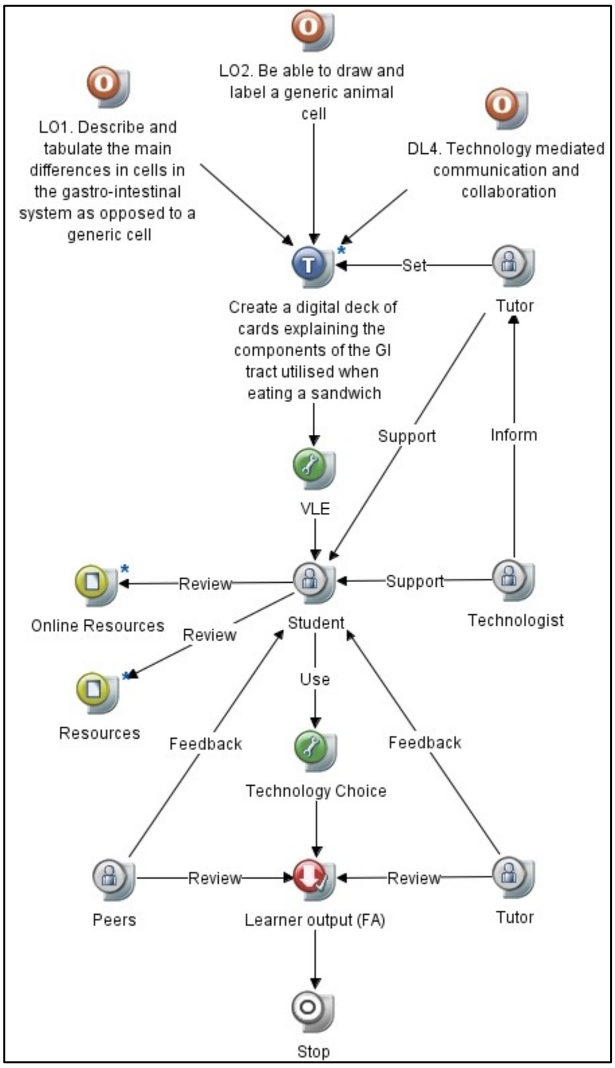
Objectives

1. Describe and tabulate the main differences in cells in the gastro-intestinal system as opposed to a generic cell.
2. Describe the route a cheese sandwich will take through the GI tract.

Learning Materials

The usual anatomy and physiology textbooks, Coad, Stables Marieb etc.

- Your Digestive System and How It Works (US Department of Health)
- Anatomy and Physiology (Leicester)
- The Gastrointestinal System (WikiBooks)



Task

Prepare a bread sandwich with protein and vegetables of your choice. As you are eating consider which components of the GI tract are being utilised in the processes. Review the literature to ensure that you understand the topic in sufficient depth. Negotiate within your skills groups to ensure that all processes within the digestive journey of your sandwich are covered.

The output of this activity should be the creation of a deck of cards fully describing the digestive journey between the team. Each card should contain an informative title and a brief description. The number of cards should match the number of identified processes and should be uploaded on your personal Activities Contributions Document Library folder.

If you would like feedback from your peers please upload your files in the repository below.

You can post your feedback on the discussion board below.

Completion

This activity must be completed prior to the taught session on Nutrition in Pregnancy.

Activity 07 - Blood, Lymphatic's and Immunity

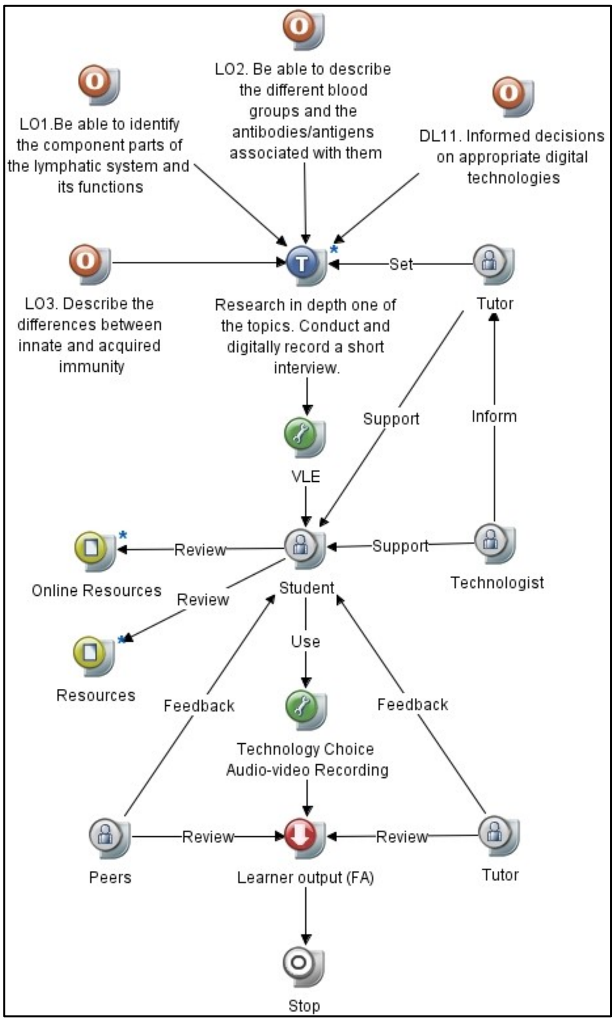
Objectives

1. Be able to identify the component parts of the lymphatic system and its functions.
2. Be able to describe the different blood groups and the antibodies/antigens associated with them.
3. Describe the differences between innate and acquired immunity.

Learning Materials

The usual anatomy and physiology textbooks, Coad, Stables Marieb etc.

- The Immune System (WikiBooks)
- Blood physiology (WikiBooks)
- Structural Biochemistry (WikiBooks)



Task

Ensure that you are familiar with the topics, within your skills groups organise yourselves in pairs and negotiate so as all of the above topics are covered. With your partner plan, conduct and record a short interview. One of you plays the role of the interviewer and the other that of the expert interviewee. Compile three questions which will allow the expert to fully verbalise the answers to one of the above objectives. The interviewer should ensure that the interviewee is on topic and that the interview is recorded.

The output of this activity should be uploaded on your personal Activities Contributions Document Library folder and shared with your peers for feedback by uploading your files in the repository below.

You can post your feedback on the discussion board below.

Completion

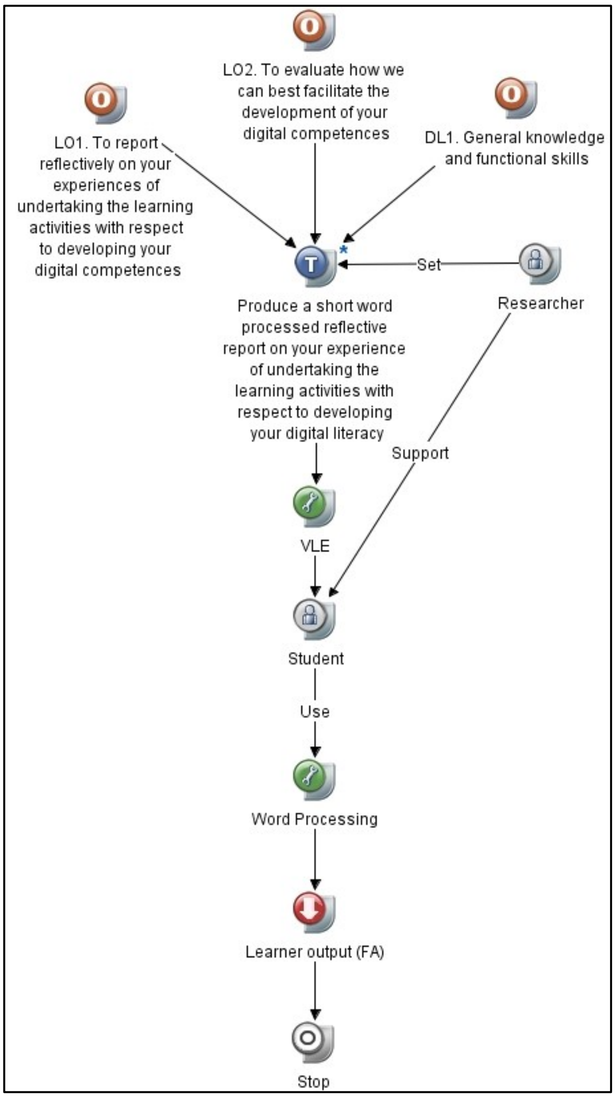
This activity must be completed prior to the taught session on Antenatal Screening.

Activity 08 - Evaluating your Learning Activities and Digital Competence Reflection

Objectives

1. To report reflectively on your experiences of undertaking the learning activities with respect to developing your digital competences.
2. To evaluate how we can best facilitate the development of your digital competences.

Task

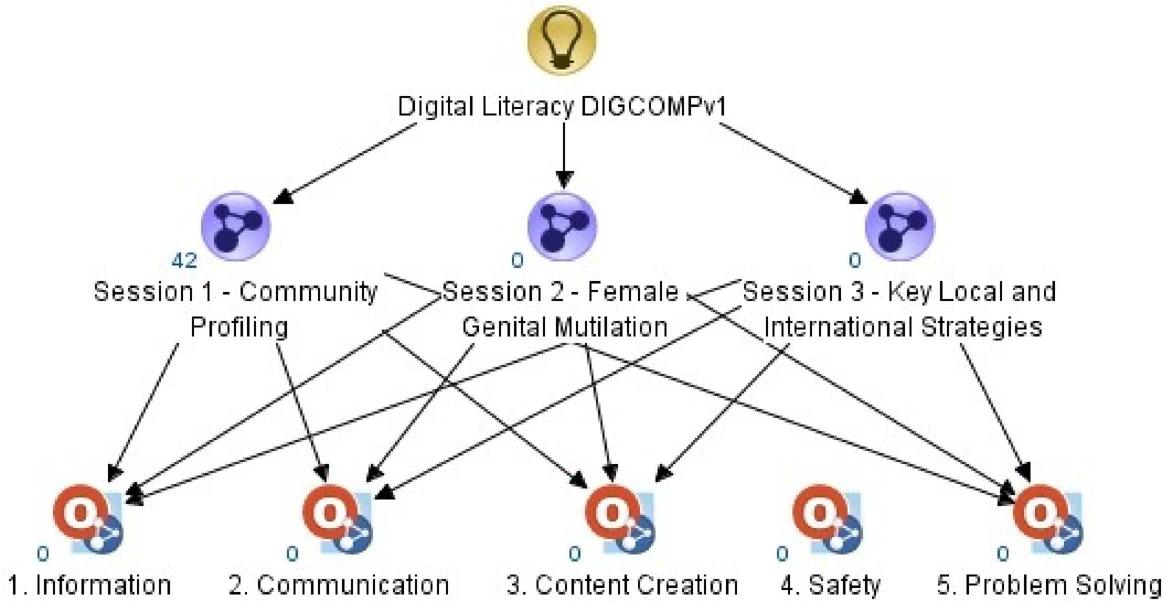


Well done for completing all previous activities! In this last activity we would like you to report reflectively on your experience of undertaking the learning activities with respect to developing your digital competences. This should include your thoughts, feelings and your experiences of completing the learning activities by the utilisation of technology. These could include things that you have learnt, issues that you faced and how you managed to overcome them or anything else that you feel is pertinent on the self-development of your digital skills and competences. We would also like you to suggest ways that we can best facilitate the development of your digital competences. The outcome of your work should be an electronic resource (something in the range of 400 to 700 words) that should be uploaded on your personal Activities Contributions Document Library folder and in the document library below.

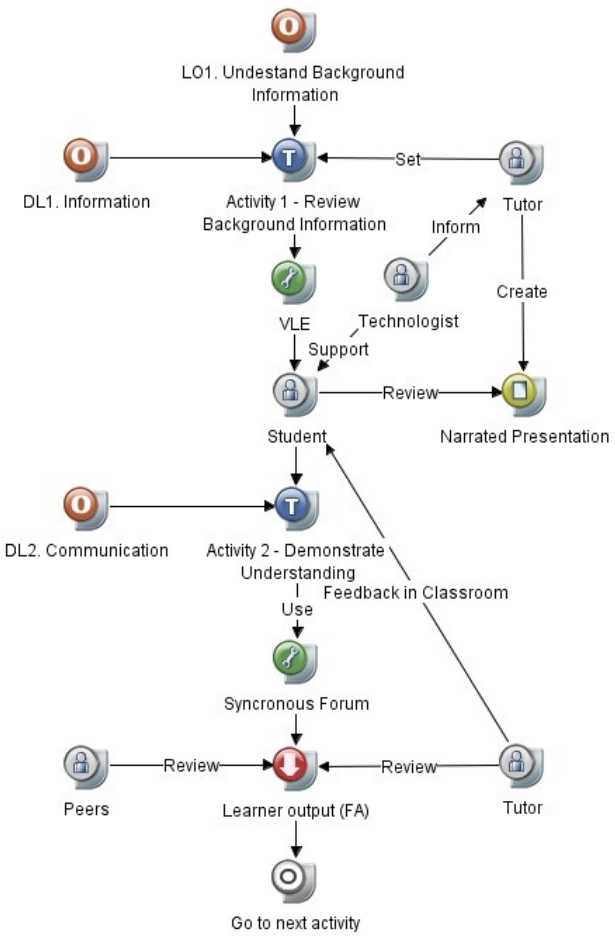
Completion

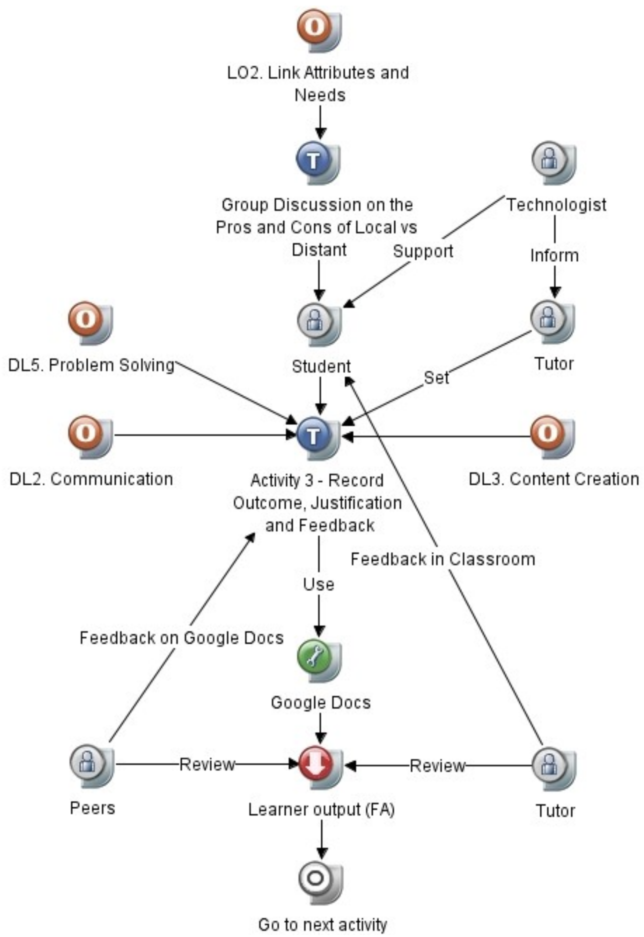
This is the last activity and should be completed by Week 12.

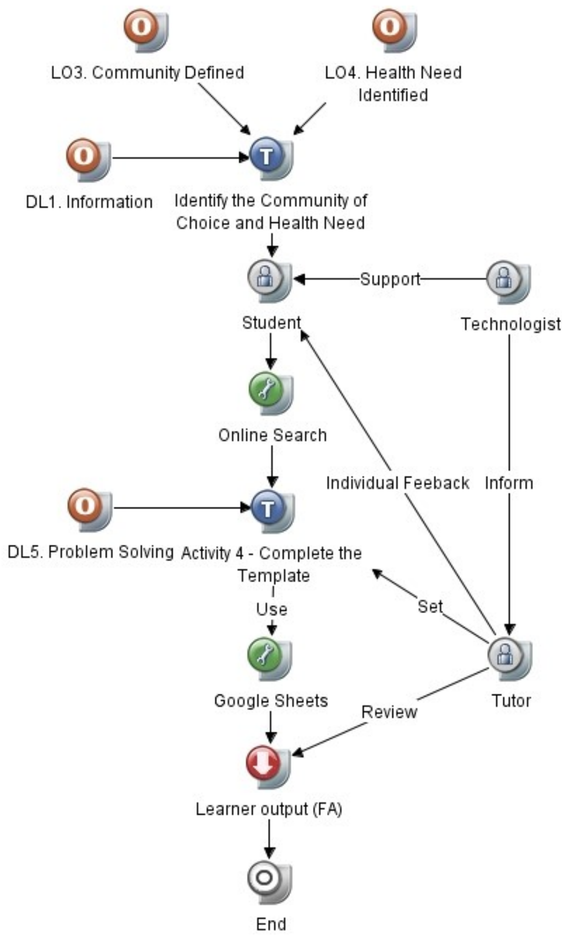
Learning Designs - Classroom Delivery based on DigComp$_{v1}$



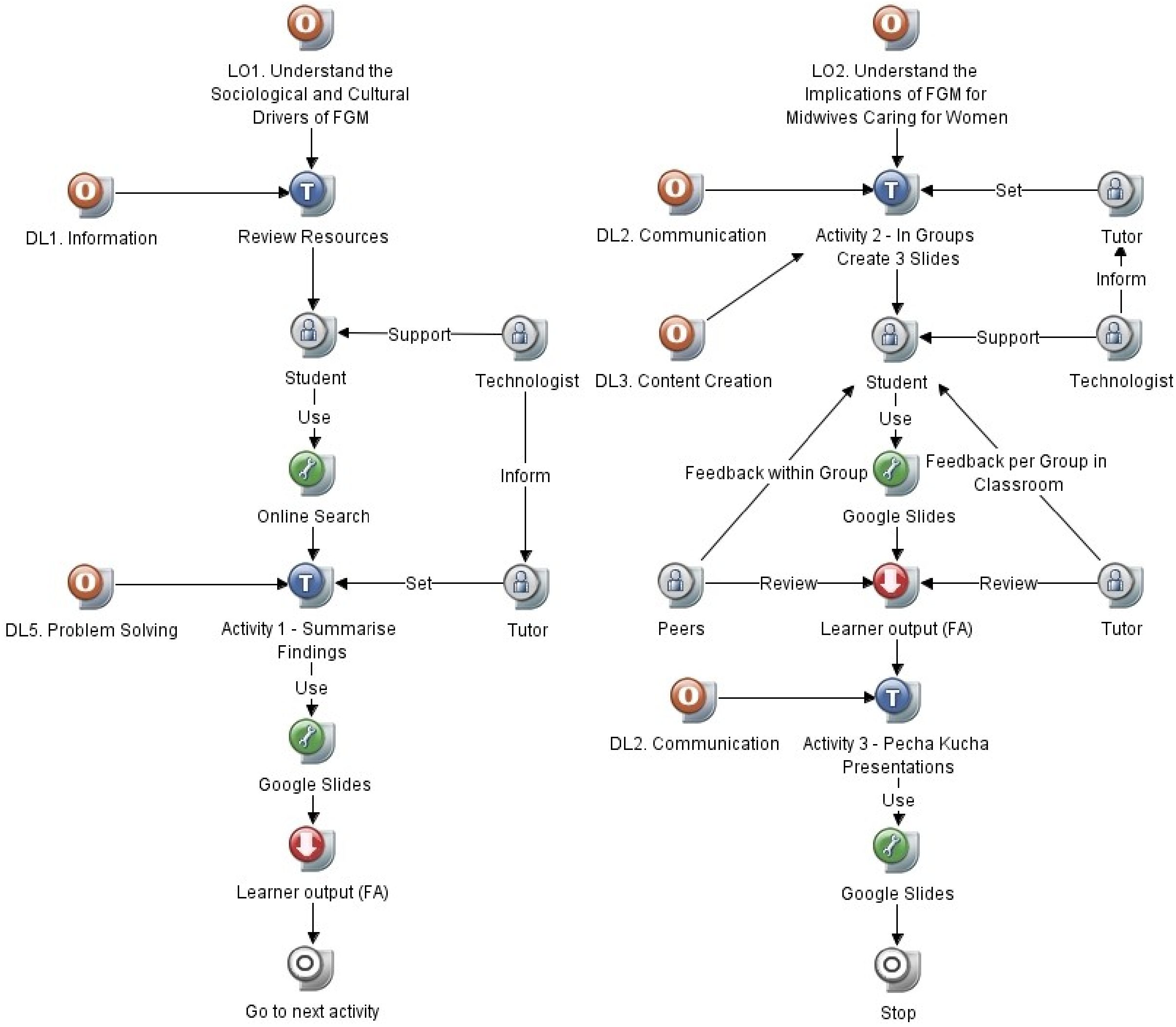
Session 01 - Community Profiling



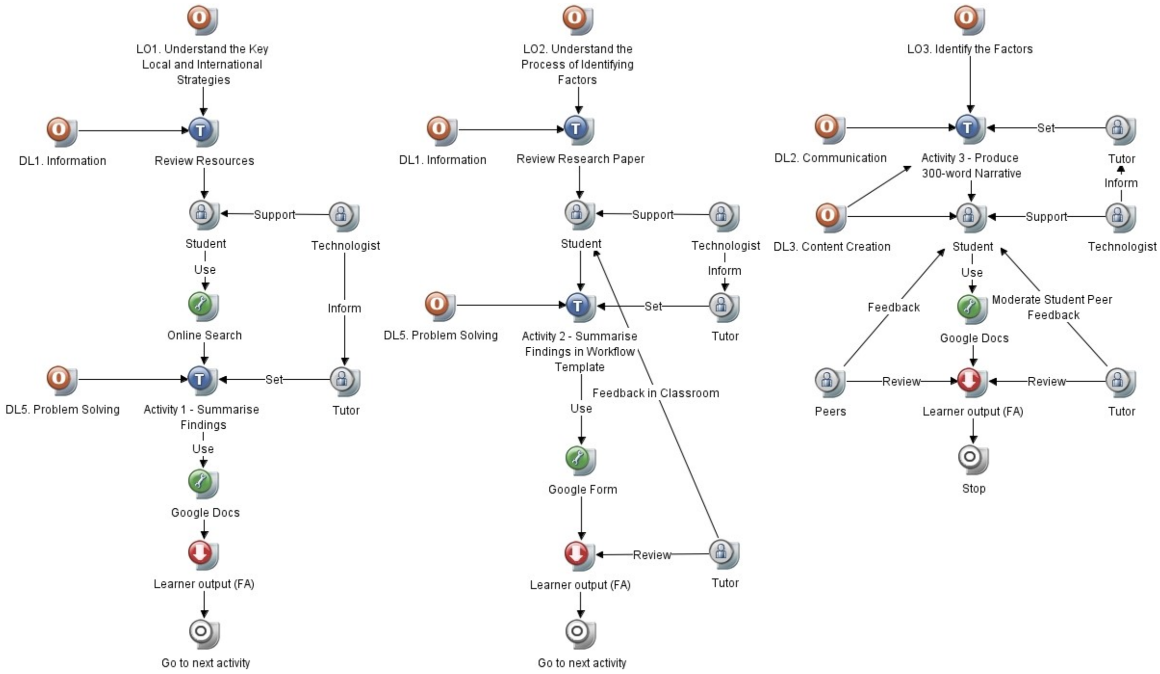




Session 02 - Female Genital Mutilation



Session 03 - Key Local and International Strategies



Appendix 12 - Digital Literacy Areas Spearman Correlation Coefficient $DigComp_{v1}$

Digital Literacy Areas Spearman Correlation Coefficient $DigComp_{v1}$ (pairs of)				
Correlation Coefficients for Digital Literacy Area 1				
Area	**2**	**3**	**4**	**5**
Spearman	0.61297	0.450518	0.414165	0.492857
Alpha	0.05	0.05	0.05	0.05
rho	0.61297	0.450518	0.414165	0.492857
t-stat	7.110398	4.625013	4.170375	5.191417
p-value	3.54E-10	1.35E-05	7.37E-05	1.43E-06
Correlation Coefficients for Digital Literacy Area 2				
	Area	**3**	**4**	**5**
	Spearman	0.650585	0.599063	0.616266
	Alpha	0.05	0.05	0.05
	rho	0.650585	0.599063	0.616266
	t-stat	7.851517	6.857115	7.171936
	p-value	1.2E-11	1.11E-09	2.68E-10

Correlation Coefficients for Digital Literacy Area 3				
		Area	**4**	**5**
		Spearman	0.616778	0.636261
		Alpha	0.05	0.05
		rho	0.616778	0.636261
		t-stat	7.181546	7.558824
		p-value	2.56E-10	4.6E-11
Correlation Coefficients for Digital Literacy Area 4				
			Area	**5**
			Spearman	0.595751
			Alpha	0.05
			rho	0.595751
			t-stat	6.798247
			p-value	1.44E-09

Appendix 13 - TOOL_01 Questionnaire DigComp$_{v0}$

Digital Competence Self Evaluation

Demographics

Please provide your demographic information.

1. Personal information

Name

Surname

Email

Telephone

2. What is your gender?

- Female
- Male

3. Which category below includes your age?

- 18-25
- 26-35
- 36-45
- 46-55
- 56-65
- 66 or older
- Prefer not to say

Digital Competence Self Evaluation

4. What is your Ethnic background?

- ◯ White - British
- ◯ White - Irish
- ◯ White - Other
- ◯ Mixed - White and Black Caribbean
- ◯ Mixed - White and Black African
- ◯ Mixed - White and Asian
- ◯ Mixed - Other
- ◯ Asian or Asian British - Indian
- ◯ Asian or Asian British - Pakistani
- ◯ Asian or Asian British - Bangladeshi
- ◯ Asian - Other
- ◯ Black or Black British - Caribbean
- ◯ Black or Black British - African
- ◯ Black or Black British - Other
- ◯ Chinese
- ◯ Prefer not to say
- ◯ Other (please specify)

5. What is your approximate household income?

- ◯ Under £20,000
- ◯ £20,001 - £30,000
- ◯ £30,001 - £50,000
- ◯ £50,001 - £70,000
- ◯ £70,001 - £90,000
- ◯ £90,001 - £110,000
- ◯ Over £110,000
- ◯ Prefer not to say

Digital Competence Self Evaluation

6. What is the highest level of education you have completed?

- GCSE/O Levels
- A Levels
- Diploma
- Bachelor's Degree
- Master's Degree
- Doctorate
- Prefer not to say
- Other (please specify)

7. Which of the following categories best describes your employment status?

- Employed, working 1-39 hours per week
- Employed, working 40 or more hours per week
- Not employed, looking for work
- Not employed, NOT looking for work
- Retired
- Disabled, not able to work
- Prefer not to say

Self Evaluation

Please consider the below statements and rate them according to your agreement or disagreement.

Digital Competence Self Evaluation

*8. General knowledge and functional skills

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I am able to use a digital device, which may be one of many types (e.g. Desktop PC, Laptop, Tablet, Smart phone).	◯	◯	◯	◯	◯	◯	◯
I possess general computer skills (typing, using computers, getting into a new programme).	◯	◯	◯	◯	◯	◯	◯
I understand the difference between hardware and software.	◯	◯	◯	◯	◯	◯	◯
I am familiar with the meaning of terms commonly used in user manuals for the operation of hardware and the installation and configuration of software.	◯	◯	◯	◯	◯	◯	◯
I know about the existence of various operating systems.	◯	◯	◯	◯	◯	◯	◯

*9. Use in everyday life

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I am able to download and access different information types from the Internet.	◯	◯	◯	◯	◯	◯	◯
I am able to use at least office applications (or other work related applications) to edit and create content (text, numeric, images).	◯	◯	◯	◯	◯	◯	◯
I am able to search, collect, process, evaluate, share, store data and information using various devices, applications, cloud services.	◯	◯	◯	◯	◯	◯	◯
I can conduct transactions online (e.g. pay bills, apply for a job, submit tax declaration, complete online forms, book a hotel, interact with government or local services, shop online, etc.).	◯	◯	◯	◯	◯	◯	◯
I consult digital resources as a matter of routine across various aspects of life (news, health, sports, travel, entertainment, etc.).	◯	◯	◯	◯	◯	◯	◯

Digital Competence Self Evaluation

*10. Specialised and advanced competence for work and creative expression

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I use technology to improve the quality of my work.	○	○	○	○	○	○	○
I have mastered specialised digital skills needed by his/her area of work.	○	○	○	○	○	○	○
I am able to create knowledge representations (e.g. mind maps, diagrams) using digital media.	○	○	○	○	○	○	○
I am able to use a variety of media to express myself creatively (text, images, audio, and movie).	○	○	○	○	○	○	○
I am able to remix different existing content into something new.	○	○	○	○	○	○	○

*11. Technology mediated communication and collaboration

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I am able to communicate through ICT (e.g. email, instant messaging, video conferencing.).	○	○	○	○	○	○	○
I am able to use social media and participative technology.	○	○	○	○	○	○	○
I am able to use digital media to be part of a community.	○	○	○	○	○	○	○
I am able to take advantage of digital technology to cooperate and take part in networks and networked learning for personal or professional purposes.	○	○	○	○	○	○	○
I can use ICT for team work (collaboration, co-construction of content); to work at a distance.	○	○	○	○	○	○	○

Digital Competence Self Evaluation

***12. Information processing and management**

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No reposne
I am able to judge the validity of content found on the Internet, how to find appropriate material, and what sources can be trusted.	○	○	○	○	○	○	○
I am able to compare and contrast information from diverse sources (triangulate information) before it is used in a knowledge-making process.	○	○	○	○	○	○	○
I am able to gather relevant digital information, e.g. other users' experiences, and to assess the quality of goods based on that information.	○	○	○	○	○	○	○
I can integrate, compare and put together different types of information related to multimodal content.	○	○	○	○	○	○	○
I am able to structure, classify, and organise digital information/content according to a certain classification scheme or genre.	○	○	○	○	○	○	○

Digital Competence Self Evaluation

*13. Privacy and security

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I understand the risks associated with online use and encounters with unknown persons.							
I am aware of privacy issues when using Internet/mobile Internet and I am able to act prudently.							
I am able to protect myself from threats of the digital world (fraud, malware, viruses etc.).							
I understand the risk of identity theft and other credentials' thefts and I am able to take steps to mitigate risk.							
I know that many interactive services use information about me to filter in commercial messages in more or less explicit manners.							

*14. Legal and ethical aspects

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I am able to communicate and collaborate with others in line with codes of conduct appropriate to the context.							
I am considerate towards legal and ethical principles of use and publication of information.							
I understand copyright and licence rules.							
I am aware of the different ways of licensing intellectual property production and I understand the differences between using copyright, public domain, copyleft and/or creative commons licenses.							
I have an advanced sense of suitable behaviour, finely tuned to media context, audience and legal provisions.							

Digital Competence Self Evaluation

*15. Balanced attitude towards technology

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I have a positive but realistic attitude towards the benefits and risks associated with information technologies.	○	○	○	○	○	○	○
I understand that the digital environment we are facing can make things better or worse - it all depends on how we are using it and what rules we find for it.	○	○	○	○	○	○	○
I am able to assess and reduce/avoid technology related threats to my health.	○	○	○	○	○	○	○
I use digital media and tools without fear, always aware that digital enablers should serve the human being to have a better life (and not the opposite).	○	○	○	○	○	○	○
I see digital media as enablers rather than inhibitors of choice and action.	○	○	○	○	○	○	○

*16. Understanding and awareness of role of ICT in society

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I understand the role of ICT in everyday life, in social life and at work.	○	○	○	○	○	○	○
I understand the wider context of digital tools in a 'digital age' characterised by globalisation and networks.	○	○	○	○	○	○	○
I am aware of the general trends within new media even if I do not use them.	○	○	○	○	○	○	○
I understand where ICT comes from, who develops it and for what purposes.	○	○	○	○	○	○	○
I am aware of environmental issues related to the use of digital technologies.	○	○	○	○	○	○	○

Digital Competence Self Evaluation

*17. Learning about and with digital technologies

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I am able to use digital media to learn (develop myself).	○	○	○	○	○	○	○
I am able to use a digital environment for lifelong learning (formal or informal).	○	○	○	○	○	○	○
I can use ICT resources to safely expand my own knowledge and connect to the world around me.	○	○	○	○	○	○	○
I am able to learn how to work with any new digital technology by trying it out, and using its internal guidance and help.	○	○	○	○	○	○	○
I am able to adapt smoothly to new technology and to integrate technology into my environment.	○	○	○	○	○	○	○

*18. Informed decisions on appropriate digital technologies

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I understand the potential of digital devices and resources for my work.	○	○	○	○	○	○	○
I know the range of things that can be done using ICT/Internet.	○	○	○	○	○	○	○
I am able to use digital services without being completely dependent on them (or: helpless without).	○	○	○	○	○	○	○
I choose the most appropriate technologies according to the task.	○	○	○	○	○	○	○
I am aware of the most relevant or popular digital technologies used by others (e.g. peers, reputed experts).	○	○	○	○	○	○	○

Digital Competence Self Evaluation

***19. Seamless use demonstrating self-efficacy**

	Strongly agree	Agree	Agree somewhat	Disagree somewhat	Disagree	Strongly disagree	No response
I am able to arrange and develop my personal working environment as an effective and reliable system.	◯	◯	◯	◯	◯	◯	◯
I can use different ICT in a way that helps to achieve certain results more quickly, or more easily, or to achieve better results.	◯	◯	◯	◯	◯	◯	◯
I can access technology and use it without realising that I am actually using it.	◯	◯	◯	◯	◯	◯	◯
I know how to use digital equipment cost-efficiently and also time efficiently.	◯	◯	◯	◯	◯	◯	◯
I can solve a theoretical or practical problem, of individual or collective interest, through or with the support of digital tools.	◯	◯	◯	◯	◯	◯	◯

Appendix 14 - TOOL_02 Questionnaire DigComp$_{v1}$ Student

Anglia Ruskin University

Cambridge Chelmsford Peterborough

Digital Skills Self-assesment

Digital Competence Framework

Please select the examples that best match your skills from the hypothetical role-play scenarios. You will need to consider the most appropriate answer according to your current skills as if you were to carry out the activities described in the examples that follow.

This self-assessment questionnaire toolkit is an adaptation of the Digital Competence framework that was part of the Digital Competence Project (DIGCOMP), launched by the Information Society Unit at Joint Research Centre's Institute for Prospective Technological Studies (JRCIPTS) on behalf of European Union Directorate-General for Education and Culture.

* 1. Please type in your Student Identity Number (SID)

25%

Next

Anglia Ruskin University

Cambridge Chelmsford Peterborough

Digital Skills Self-assesment

Digital Competence Self-assessment

* 2. 1.1 Information - Browsing, searching and filtering information

- I can use a search engine to find details about a specific type of recycling waste.
- I can find a range of sources of information about a specific type of recycling waste by entering proper key words, and I can use a refined search to locate the most appropriate sources.
- I can find a range of sources of information about a specific type of recycling waste using different search engines and advanced searches, and I can also use online databases and searches through linked references.
- I don't have the skills to complete any of the above.

* 3. 1.2 Information - Evaluating information

- I have found some information from different sources about society in the 1500s, but I'm not sure how to judge its value.
- I have found a range of different sources about society in the 1500s, and I've looked for the origins of the material as a way to judge their value.
- I have found a range of different sources about society in the 1500s, I've looked for the sources they originate from, I've removed some because the academic nature of the sources is not clear, and I've checked details across the sources to see how valid they may be.
- I don't have the skills to complete any of the above.

* 4. 1.3 Information - Storing and retrieving information

- I have created notes about a research topic, and I've saved the text and images onto the desktop.
- I have created notes about a research topic, and I've saved these in different file formats into organised named folders.
- I have created notes about a research topic, and I've saved these into folders on my hard drive and also in a file hosting service (cloud storage), which will allow me and others to retrieve and share them easily.
- I don't have the skills to complete any of the above.

* 5. 2.1 Communication - Interacting through technologies

- I use a chat or a discussion forum to communicate with other students on my course.
- I use a chat to communicate with other students, when necessary I can also use a group chat and moderate it. When needed, I also use audio-video conference tools to talk to other students.
- I use several communication tools to communicate with other students (mobile phone, audio-video conference tools, chat or email). I use several features of audio-video conference tools – when I work on a project with other students: I can use screen share feature, I can also record a conversation and broadcast it. I know which communication tool to select, depending on the purpose and the size of the audience.
- I don't have the skills to complete any of the above.

6. 2.2 Communication - Sharing information and content

- When I complete an assignment for a course, I send it to my tutor as an email attachment for feedback.
- When I complete an assignment, I use a social networking site to ask colleagues to review it, and then submit the assignment.
- I use online communities to share a completed assignment with other students. I'm careful to make sure that their contributions are appropriately recognised before I submit the assignment.
- I don't have the skills to complete any of the above.

* 7. 2.3 Communication - Engaging in online citizenship

- If I want to take a new course, I know that I can search online for one to match my interests and needs, and that I'll be able to ask questions and get details from institutions that offer appropriate courses.
- I have searched for appropriate courses, and I've sent some queries to a few selected institutions, so that I can apply online.
- I am enrolled on a course, and I've also completed details so that I have a presence on the institution's social site that can be seen by others who might have similar interests.
- I don't have the skills to do any of the above.

* 8. 2.4 Communication - Collaborating through digital channels

- I need to collaborate with others on a project for a course, and I know that it is possible and effective to use technology to help with this.
- I have started to work on our project, and I have created a file that I have shared with others, so that they can offer comments and add material to it.
- I have put a document into an online collaboration tool, so that others can amend it and add to it, and the system will notify me about the changes that have been made.
- I don't have the skills to complete any of the above.

* 9. 2.5 Communication - Netiquette

- I am aware that comments sent to my tutor should be in no way offensive.
- I always re-read messages to ensure that comments are not offensive or unethical, and if I receive such comments from others, I know how to block their messages or who to inform about the problem.
- I have read official material online about ethical practices, and have also attended online sessions to keep up-to-date about any new issues which arise.
- I don't do / know any of the above.

* 10. 2.6 Communication - Managing digital identity

- I understand that people might have an idea of my personality through what I share on social networks and on the VLE.
- I keep track of the things I share on social networks and on the VLE to create an e-reputation.
- I have different identities that I apply to the learning spaces and virtual communities I participate in for improving my learning.
- I don't do / know any of the above.

* 11. 3.1 Content creation - Developing content

- I need to present my ideas to others in the class, and can use technology to do this creatively.
- I need to present my ideas to others in the class, and I can use presentation software, images, video and music to do this creatively.
- I need to present my ideas to others in the class, and know how to integrate audio, text, images, video and music in film formats.
- I don't have the skills to complete any of the above.

* 12. 3.2 Content creation - Integrating and re-elaborating

- I can edit the first draft of an assignment I produce and accept the track changes of my tutor.
- When I produce an assignment I often integrate material that I've created with figures or tables from other sources that I cite to illustrate certain points in my argument.
- When I produce an assignment I can use software that allows me to draw data from existing sources through links, without needing to copy and paste it.
- I don't have the skills to complete any of the above.

* 13. 3.3 Content creation - Copyright and licences

- I know that certain behaviour is illegal such as downloading copyright material without permission.
- I understand if the educational material I am using is covered by copyright or not and I understand which rights apply to the assignments I produce.
- I can apply different licences to the material I produce for learning and I have looked in detail at laws that relate to illegal online educational practices.
- I don't do / know any of the above.

* 14. 3.4 Content creation - Programming

- I can modify the style template of the text editor I am using.
- I can use open software to create my own reference library.
- I can create a new reference software that suits my needs.
- I don't have the skills mentioned above.

* 15. 4.1 Safety - Protecting devices

- I know university computers have to have good antivirus software, because many students use internet on the same computer.
- If I use my device on a free WiFi, I always try to secure my access (using VPN or other similar technology).
- I use different passwords for accessing the campus computers and services and I often change my passwords.
- I don't do any of the above.

* 16. 4.2 Safety - Protecting personal data

- I know the types of information that I should not share with others when I am making an application for a course.
- I understand how my data will be used by the institution I am applying to, and select an appropriate level of security setting when communicating with personnel at the institution.
- I have asked the institution how my data are retained, and what their policies are on privacy. I check my security settings and systems often, and update my security software, to make sure that breaches are reduced as much as possible.
- I don't know any of the above.

* 17. 4.3 Safety - Protecting health

- I am aware that using technologies has negative and positive aspects, for learning as they have for other purposes.
- I understand the negative and positive aspects of technology and its uses that relate to learning.
- I have read about negative and positive aspects of technology and its uses that relate to learning, and have discussed this issue in an expert forum online.
- I don't know any of the above.

* 18. 4.4 Safety - Protecting the environment

- I do not print out all the articles I should read for an exam, I first read the abstract to see if it is really relevant.
- I tend to opt for a technological solution rather than a non-technological one when I see that the digital choice has less impact on the planet.
- I would not buy a new device for learning (example: laptop, ebook reader) only for reasons of peer-pressure if my old ones are still good for the purpose.
- I don't do any of the above.

* 19. 5.1 Problem solving - Solving technical problems

- If something does not work, I know how to explain the problem to the helpline.
- When problems arise, I can usually tackle about half of them, either from previous experience or by contacting the helpline.
- Not many problems arise that I can't solve, but I still need to contact the helpline when the software is new to me.
- I don't do / know any of the above.

* 20. 5.2 Problem solving - Identifying needs and technological responses

- I use online learning environments for routine tasks, but when I face a new or ill-defined problem, I have to ask for help.
- For an assignment, I can use several approaches or technologies, but I need to take several steps to explore what serves me best.
- I can plan, monitor and critically evaluate which of many tools will best serve my study needs (which online resources, software, technology).
- I don't do / know any of the above.

* 21. 5.3 Problem solving - Innovating and creatively using technology

- I can use my smart phone for taking pictures for a university project and I create a creative artifact despite using basic digital means.
- I can use the appropriate digital tools to enhance my university assignments and to better understand and represent a conceptual problem (e.g. mind mapping).
- I use several tools for representing concepts when I structure my assignment. For example, I create wikis to collaborate with university peers on the assignment. I can think of several original technological-based initiatives.
- I don't have the skills to complete any of the above.

* 22. 5.4 Problem solving - Identification of digital competence gaps

- I know of ways that other people use technologies to support their learning that I don't use.
- I know there are courses that I can attend online that will instruct me about certain ways to use the technologies to support my learning.
- I look for a good online course to attend every six months or so to help me with my use of technologies for learning.
- I don't do / know any of the above.

60%

Prev Next

Anglia Ruskin University

Cambridge Chelmsford Peterborough

Digital Skills Self-assesment

Use of Technology

* 23. Which of the following devices have you used and in what context (Tick all that apply)?

	Formal learning	Informal learning	Research	Personal life	Work	Have not used
Smart phone (iPhone, Android, Windows Mobile, etc.)	☐	☐	☐	☐	☐	☐
Mobile telephone with internet access	☐	☐	☐	☐	☐	☐
Mobile telephone without internet access	☐	☐	☐	☐	☐	☐
Laptop computer	☐	☐	☐	☐	☐	☐
Netbook computer	☐	☐	☐	☐	☐	☐
Desktop computer	☐	☐	☐	☐	☐	☐
Tablet device (iPad, Galaxy Tab, MS Surface, etc.)	☐	☐	☐	☐	☐	☐
eReader (Kindle, Nook, Kobo, etc.)	☐	☐	☐	☐	☐	☐
iPod/MP3 Player	☐	☐	☐	☐	☐	☐
Digital Camera (photography)	☐	☐	☐	☐	☐	☐
Digital Camera (videography)	☐	☐	☐	☐	☐	☐

* 24. How do you find out about new digital technologies (Tick all that apply)?

☐ Friends/Family

☐ Online/Digital source

☐ Traditional media (TV/Radio/Newspaper)

☐ Library services

☐ Part of my course at university

☐ Part of my CPD at work

☐ Professional or other specialist networks

☐ Other (please specify)

75%

Prev Next

Anglia Ruskin University

Cambridge Chelmsford Peterborough

Digital Skills Self-assesment

Demographics

* 25. What is your gender?

- Female
- Male
- Prefer not to say
- Other (please specify)

* 26. In which age category do you belong?

- 17 or under
- 18-25
- 26-35
- 36-45
- 46-55
- 56-65
- 66 or older
- Prefer not to say

100%

Prev Done

8

Appendix 15 - TOOL_03 Questionnaire DigComp$_{v1}$ Staff

Technology

Information

This survey is an evaluation into Anglia Ruskin's technology enhanced learning and teaching provision. The survey seeks feedback on your user experience so far.

The findings will inform the further development and implementation of learning technologies in the faculty.

The information that is collected from you will be anonymised and stored on a password protected computer. No reference, either direct or indirect, will be made to you as an individual in any publications of any kind.

If you have any queries please do not hesitate to contact George Evangelinos at george.evangelinos@anglia.ac.uk.

Technology

You and the University

***1. What is your predominant teaching delivery mode?**

- Face-to-face
- Distance Learning
- Work-based
- Other (please specify)

***2. Which department are you attached to?**

Technology

Digital Competence Framework

Please select the examples that <u>best match your skills</u> from the hypothetical role-play scenarios. You will need to consider the most appropriate answer according to your current skills as if you were to carry out the activities described in the examples that follow.

This self-assessment questionnaire toolkit is an adaptation of the Digital Competence framework that was part of the Digital Competence Project (DIGCOMP), launched by the Information Society Unit at Joint Research Centre's Institute for Prospective Technological Studies (JRCIPTS) on behalf of European Union Directorate-General for Education and Culture.

Technology

Digital Competence Self-assessment

***3. 1.1 Information - Browsing, searching and filtering information**

- ◯ I can find details of flights using a common search engine.
- ◯ I can find details of flights using a number of search engines, and a number of airline company websites, selecting details that relate to scheduled times.
- ◯ I can find details of flights using a number of search engines, airline company web sites, and web sites that compare details of many airline companies, including costs and scheduled times.
- ◯ I don't have the skills to complete any of the above.

***4. 1.2 Information - Evaluating information**

- ◯ I have been asked to look at student numbers on a course, but I'm not sure how reliable the figures that I've obtained are.
- ◯ I have been asked to look at student numbers on a course, and I've checked the sources of figures that I've obtained so I have an idea of how reliable they may be.
- ◯ I have been asked to look at student numbers on a course, I've checked the sources of figures that I've obtained so I have an idea of how reliable they may be. I've taken out those that appear to be unreliable, and I will check with colleagues or experts about the likely validity of those that appear to be more consistent.
- ◯ I don't have the skills to complete any of the above.

***5. 1.3 Information - Storing and retrieving information**

- ◯ When I prepare my teaching, I know how to save files that are created in text, pdf or video format.
- ◯ I can save text, pdf and video formats of teaching material and file these into named folders so I can find them easily later.
- ◯ I have saved text, pdf, video and audio files of teaching material, and back-up copies from my hard drive onto a shared file drive for others to access, and into a file hosting service (cloud storage) for colleagues in other campuses and regions to access and share easily.
- ◯ I don't have the skills to complete any of the above.

***6. 2.1 Communication - Interacting through technologies**

- ◯ I handle travel arrangements and use a mobile telephone and email to communicate with others.
- ◯ When I handle travel arrangements I use a mobile telephone a lot, but also use email and VoIP to communicate with some people. I can organize a discussion with more participants using VoIP.
- ◯ When I travel I use several communication tools (e.g. (mobile phone, VoIP, chat or email), I can organise a meeting using VoIP, using different features (file, screen sharing, recording the conversation), I can also run a video-conference among remote sites and moderate it. I know when to use VoIP and when videoconference tools.
- ◯ I don't have the skills to complete any of the above.

***7. 2.2 Communication - Sharing information and content**

- ◯ I share documents that are in draft form with other colleagues in the faculty, sending them by email as file attachments.
- ◯ I share documents that are in draft form with other colleagues in the faculty, perhaps sending them as attached files if their distribution is limited, or I share them through a shared repository if the distribution is for wider groups.
- ◯ I share documents that are in draft form with colleagues in the faculty and in other faculties/services, selecting different networks depending on width of distribution.
- ◯ I don't have the skills to complete any of the above.

Technology

*8. 2.3 Communication - Engaging in online citizenship

- ◯ As an employee, I use community's web pages, where I occasionally read news, information and regulations in the field.
- ◯ I have applied online to become a member of a community. I use the services e.g. news feed; I regularly read news, information and regulations in the field.
- ◯ I actively participate in a community's online portal, I engage in civic activities (like signing petitions) and using services such as legal aid.
- ◯ I don't have the skills to do any of the above.

*9. 2.4 Communication - Collaborating through digital channels

- ◯ I need to create a handbook in collaboration with others in the department, and know that I can use technology to help with this.
- ◯ I have created a handbook, and have shared it with others so that they can comment on it and add material to it.
- ◯ I have created a handbook, and put it into an online collaboration tool, so that the others working on it with me can amend it and add to it. The system will alert me to the changes when these are being made, so that I can collaborate with them synchronously if I wish.
- ◯ I don't have the skills to complete any of the above.

*10. 2.5 Communication - Netiquette

- ◯ I am aware that comments placed on the university emails should be in no way offensive.
- ◯ I always re-read messages that are placed on our university emails to ensure that comments are not offensive or unethical, and if I receive such comments from others, I know how to block their messages or who to inform about the problem.
- ◯ I have read official material about ethical practices, and have also attended sessions to keep up-to-date about any new issues which arise, particularly relating to educational institutions.
- ◯ I don't do / know any of the above.

*11. 2.6 Communication - Managing digital identity

- ◯ I am aware that I can have a public profile on a social network dedicated to people in professional occupations.
- ◯ I have a profile on a social network that I use for professional purposes and I only share professional information through that profile.
- ◯ I manage my professional profile and use online services to keep track of the projects/research outputs I am involved in and academic work I produce.
- ◯ I don't do / know any of the above.

*12. 3.1 Content creation - Developing content

- ◯ I need to present my ideas to my team, and I can use basic technologies to do this creatively.
- ◯ I need to present my ideas to my team, and can use presentation software, images, video and music to do this creatively.
- ◯ I need to present my ideas to my team, and know how to integrate audio, text, images, video and music in film formats.
- ◯ I don't have the skills to complete any of the above.

Technology

*13. 3.2 Content creation - Integrating and re-elaborating

◯ I can edit a newsletter draft texts that my colleague sent me for revision.

◯ I need to create a new newsletter every month, and I combine material from different sources that are sent to me.

◯ I need to create a new newsletter every month, and I use a template that allows me to draw data from sources that are sent to me, without needing to copy and paste them.

◯ I don't have the skills to complete any of the above.

*14. 3.3 Content creation - Copyright and licences

◯ I know the consequences of making comments about competing institutions that might be construed as defamatory or negative.

◯ I have an intuitive knowledge of laws that apply to business conduct and commercial practices online use.

◯ I have attended specialist sessions looking at laws that relate to copyright, intellectual property and legality of online practices.

◯ I don't do / know any of the above.

*15. 3.4 Content creation - Programming

◯ I can use software to modify resources that have been produced by someone else.

◯ I can author a webpage with the help of user-friendly web editing tools.

◯ I can programme webpages using different programming languages.

◯ I don't have the skills mentioned above.

*16. 4.1 Safety - Protecting devices

◯ I have a strong password set on my computers, so only I can access them.

◯ If I am installing a software from the internet, I use services, which can scan the file online such as an up-to-date anti virus software.

◯ When I am using cloud storage services for sharing, I encrypt the files with the most confidential information.

◯ I don't do any of the above.

*17. 4.2 Safety - Protecting personal data

◯ I know the types of information that I should ask of students when they make an enquiry.

◯ I have an intuitive idea of how data is held by the university, and select an appropriate level of security setting when communicating with personnel within and outside the university.

◯ I know how data is retained in the university, and what its policies are on privacy. I check my security settings and systems often, security software is automatically updated, and I know who to contact if I believe there are possible problems.

◯ I don't do / know any of the above.

Technology

*18. 4.3 Safety - Protecting health

- ◯ I am aware that using technologies can be detrimental to my health, when they are used for employment as they are for other purposes.
- ◯ I understand the negative and positive aspects of technology and its uses that relate to academic life and specifically in my area of employment.
- ◯ I have read about negative and positive aspects of technology and its uses that relate to my area of employment, and have discussed the potential issues with the relevant university health and safety officer.
- ◯ I don't know any of the above.

*19. 4.4 Safety - Protecting the environment

- ◯ I switch off my computer when I leave the office.
- ◯ I understand that my needs to have new devices for work can have an impact on the environment.
- ◯ I research the most efficient technological devices and software before asking for my work equipment to be changed.
- ◯ I don't do / know any of the above.

*20. 5.1 Problem solving - Solving technical problems

- ◯ If something does not work, I know there is a university helpline and service desk to contact and I am able to explain the problem.
- ◯ When problems arise, I can usually tackle about half of them, either from previous experience or by contacting the university helpdesk.
- ◯ Not many problems arise that I can't solve, but I still need to contact the university helpdesk when the software is new to me.
- ◯ I don't do / know any of the above.

*21. 5.2 Problem solving - Identifying needs and technological responses

- ◯ I use online resources for solving certain (routine) tasks.
- ◯ When I face a task I am not familiar with or if the task is not very well defined, I can explore different possibilities (tools, technologies) and make a decision about which is the most effective.
- ◯ At work, I select and order the technology and tools that are most appropriate for my business needs. I am able to select from several products the one which will serve my needs best. I can plan and monitor the steps taken.
- ◯ I don't do any of the above.

*22. 5.3 Problem solving - Innovating and creatively using technology

- ◯ I can use simple software provided in my workplace in ways that were not necessarily those that the software was created for.
- ◯ I can use project management software to plan, organize, and manage resource pools. I can use software and applications that help me visualize or organize a complex task and therefore see it in a different way.
- ◯ I know that technologies can help me understand better how to organize staff, resources, financial issues and actions in my team and I use a variety of specialized software to help me predict the future needs of my project and team.
- ◯ I don't do / know any of the above.

Technology

***23. 5.4 Problem solving - Identification of digital competence gaps**

- ◯ I know of ways that other people in the university use technologies to support their work that I don't use.
- ◯ I know there are courses that I can attend that will instruct me about certain ways to use the technologies to support my work.
- ◯ I am expected to attend a recommended course at least once a year to help me with my use of technologies for my work.
- ◯ I don't do / know any of the above.

Technology

Use of Technology

***24. Which of the following devices have you used and in what context (Tick all that apply)?**

	Personal life	Work	Teaching	Study	Research	Have not used
Smart phone (iPhone, Android, Windows Mobile, etc.)	☐	☐	☐	☐	☐	☐
Mobile telephone with internet access	☐	☐	☐	☐	☐	☐
Mobile telephone without internet access	☐	☐	☐	☐	☐	☐
Laptop computer	☐	☐	☐	☐	☐	☐
Netbook computer	☐	☐	☐	☐	☐	☐
Desktop computer	☐	☐	☐	☐	☐	☐
Tablet device (iPad, Galaxy Tab, MS Surface, etc.)	☐	☐	☐	☐	☐	☐
eReader (Kindle, Nook, Kobo, etc.)	☐	☐	☐	☐	☐	☐
iPod/MP3 Player	☐	☐	☐	☐	☐	☐
Digital Camera (photography)	☐	☐	☐	☐	☐	☐
Digital Camera (videography)	☐	☐	☐	☐	☐	☐

***25. How do you find out about new digital technologies (Tick all that apply)?**

- ☐ Friends/Family
- ☐ Work Colleagues
- ☐ Online/Digital source
- ☐ Recommended by students
- ☐ Part of my CPD
- ☐ Traditional media (TV/Radio/Newspaper)
- ☐ Librarians
- ☐ Professional networks
- ☐ Other (please specify)

Technology

***26. How often do you use the following university services / technologies?**

	Daily	Weekly	Monthly	Infrequently	Never	I am unaware of this
Email	◯	◯	◯	◯	◯	◯
Office Communications Server (instant messaging, computer-based audio video conference)	◯	◯	◯	◯	◯	◯
Adobe Connect (virtual classroom, computer-based audio video conference)	◯	◯	◯	◯	◯	◯
Virtual Learning Environment (VLE)	◯	◯	◯	◯	◯	◯
MyPlayer (ARU online media service)	◯	◯	◯	◯	◯	◯
Echo 360 (lecture capture)	◯	◯	◯	◯	◯	◯
Echo 360 (personal capture)	◯	◯	◯	◯	◯	◯
iTunes U	◯	◯	◯	◯	◯	◯
VMWare (remote desktop)	◯	◯	◯	◯	◯	◯
Turnitin Plagiarism	◯	◯	◯	◯	◯	◯
Turnitin Grademark (e-submission)	◯	◯	◯	◯	◯	◯
Questionmark Perception (quiz, online assessment tool)	◯	◯	◯	◯	◯	◯
Library searches	◯	◯	◯	◯	◯	◯
e-Vision (manage my modules, timetable, etc.)	◯	◯	◯	◯	◯	◯
Talis Aspire (reading lists)	◯	◯	◯	◯	◯	◯
Qlickview (institutional reporting tools)	◯	◯	◯	◯	◯	◯
Text tools (SMS communication and feedback)	◯	◯	◯	◯	◯	◯
Every Poll (classroom feedback tool)	◯	◯	◯	◯	◯	◯

Other (please specify)

Technology

Virtual Learning Environment (VLE) Tools

***27. Please rate the VLE tools below in terms of usefulness for your teaching:**

	Very useful	Useful	Neutral	Not so useful	Not at all useful	I have not used it
Content (usually a table of contents with links to resources, may include further pages with instructions etc.)	◯	◯	◯	◯	◯	◯
Documents (module documents)	◯	◯	◯	◯	◯	◯
Shared Documents (document library where students can upload and edit)	◯	◯	◯	◯	◯	◯
Weblinks (list of external links)	◯	◯	◯	◯	◯	◯
Discussions (generic discussion board - Ask the Tutor, Cafe or similar)	◯	◯	◯	◯	◯	◯
Additional Discussions (online learning activities)	◯	◯	◯	◯	◯	◯
Announcements	◯	◯	◯	◯	◯	◯
Calendar	◯	◯	◯	◯	◯	◯
Student Wiki (wiki which students can edit)	◯	◯	◯	◯	◯	◯
Blogs	◯	◯	◯	◯	◯	◯
Survey	◯	◯	◯	◯	◯	◯
Assignment (formative e-submission tool)	◯	◯	◯	◯	◯	◯

Comments

Technology

*28. Please rate the VLE tools below in terms of their ease-of-use:

	Very easy to use	Easy to use	Neutral	Difficult to use	Very difficult to use	I have not used it
Content (usually a table of contents with links to resources, may include further pages with instructions etc.)	◯	◯	◯	◯	◯	◯
Documents (module documents)	◯	◯	◯	◯	◯	◯
Shared Documents (document library where students can upload and edit)	◯	◯	◯	◯	◯	◯
Weblinks (list of external links)	◯	◯	◯	◯	◯	◯
Discussions (generic discussion board - Ask the Tutor, Cafe or similar)	◯	◯	◯	◯	◯	◯
Additional Discussions (online learning activities)	◯	◯	◯	◯	◯	◯
Announcements	◯	◯	◯	◯	◯	◯
Calendar	◯	◯	◯	◯	◯	◯
Student Wiki (wiki which students can edit)	◯	◯	◯	◯	◯	◯
Blogs	◯	◯	◯	◯	◯	◯
Survey	◯	◯	◯	◯	◯	◯
Assignment (formative e-submission tool)	◯	◯	◯	◯	◯	◯

Comments

*29. Have you used the Content wiki to organise / scaffold your module content?

◯ Yes ◯ No ◯ I don't know

Technology

Content Wiki

***30. Please indicate how you have used the Content wiki (Tick all that apply):**

- [ ] Table of contents (one page)
- [ ] Table of contents with links to resources (one page)
- [ ] Used a structure involving a number of pages (content, instructions, links to resources)
- [ ] Embedded media (Youtube, MyPlayer, Slideshare, Prezi, Echo 360, etc.)
- [ ] Embedded VLE tools (discussion board, document libraries etc.)
- [ ] Embedded 'web-parts' (Questionmark Perception, RSS feed, Twitter feed)
- [ ] Other (please specify)

Technology

Virtual Learning Environment (VLE) General

***31. Please rate your agreement / disagreement with the following statements:**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	I don't know
I find the VLE easy to use	○	○	○	○	○	○
I feel supported in the use of the VLE	○	○	○	○	○	○
The VLE is reliable in terms of access	○	○	○	○	○	○
I make good use of the VLE	○	○	○	○	○	○
The VLE gives me more opportunities to support and scaffold my students' learning	○	○	○	○	○	○
The VLE provides me with more opportunity to complement my classroom with online teaching	○	○	○	○	○	○

Comments

***32. Please let us know one aspect of how the VLE can be improved:**

***33. Please provide examples where student feedback indicated that your use of technology enhanced their learning experience:**

Technology

34. General Comments / Suggestions / Feedback

35. We would really like to collect examples of effective technology use in learning and teaching. If you would like to contribute in sharing good practice please provide us with your name and email address below:

Name

Surname

Email address

Technology

Demographics

***36. What is your gender?**

- ◯ Female
- ◯ Male
- ◯ Prefer not to say
- ◯ Other (please specify)

***37. In which age category do you belong?**

- ◯ 17 or under
- ◯ 18-25
- ◯ 26-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56-65
- ◯ 66 or older
- ◯ Prefer not to say

Technology

***38. What is your ethnic background?**

- White - British
- White - Irish
- White - Other
- Mixed - White and Black Caribbean
- Mixed - White and Black African
- Mixed - White and Asian
- Mixed - Other
- Asian or Asian British - Indian
- Asian or Asian British - Pakistani
- Asian or Asian British - Bangladeshi
- Asian - Other
- Black or Black British - Caribbean
- Black or Black British - African
- Black or Black British - Other
- Chinese
- Prefer not to say
- Other (please specify)

***39. What is the highest level of education you have completed?**

- GCSE/O Levels
- A Levels
- Diploma
- Bachelor's Degree
- Master's Degree
- Doctorate
- Prefer not to say
- Other (please specify)

Technology

***40. Which of the following categories best describes your employment status?**

- ◯ In employment, full-time
- ◯ In employment, part-time
- ◯ In employment, zero hours (Hourly paid)
- ◯ In employment, freelance / consultant / contractor
- ◯ In employment, fixed term
- ◯ Not employed, looking for work
- ◯ Not employed, NOT looking for work
- ◯ Retired
- ◯ Prefer not to say

***41. Which of the following best defines your socio-economic group?**

- ◯ High managerial, administrative or professional
- ◯ Intermediate managerial, administrative or professional
- ◯ Supervisory, clerical and junior managerial, administrative or professional
- ◯ Skilled manual workers
- ◯ Semi and unskilled manual workers
- ◯ State pensioners, casual or lowest grade workers, unemployed with state benefits only
- ◯ Prefer not to say

Appendix 16 - TOOL_04 Classroom Student Experience Questionnaire

Anglia Ruskin University

Cambridge Chelmsford Peterborough

DCNE TEL Classroom Intervention Evaluation

1. Please indicate your agreement with the following statements

	Strongly Agree	Agree	Disagree	Strongly Disagree
I enjoy working collaboratively	○	○	○	○
I learn better by engaging in activity-based learning	○	○	○	○
I feel that I have the digital skills required to complete the activities	○	○	○	○
I need more support in using technologies	○	○	○	○
I would like to have more opportunities to learn collaboratively and participate in activity-based, technology-enhanced learning	○	○	○	○

2. Do you have any other comments, questions, or concerns?

1

Appendix 17 - TOOL_05 Digital Literacy as Attribute DigComp$_{v1}$

Information Literacy			
A graduate is able to undertake digital searches and manage information, critically evaluate the authenticity of the source and recognise the importance of the different types of digital source material.			
• **A learner user uses search engines to search; saves or stores content and files in different formats; retrieves saved content and has elementary appreciation of its validity.** • **An intermediate user searches the Internet and other digital resources for information; selects appropriate information; compares a variety of different information sources; saves, stores and tags content and information; creates personal storing strategies; retrieves and manages information and content previously saved or archived.** • **An advanced user utilises a wide range of strategies when searching for information and browsing on the Internet, in repositories and specialist databases; is critical about the information found; cross-checks and assesses its validity and credibility; filters and monitors the information they receive; applies different methods and tools to organise files, content and information; deploys a set of varied strategies for retrieving and managing the content organised and stored by previous searches; knows whom to follow in online information sharing and networking places.**			
Badge	**Learner**	**Intermediate**	**Advanced**
INFORMATION SEARCH	Searches the internet through search engines	Searches the Internet and other digital repositories for information; selects only appropriate information	Utilises a wide range of strategies when searching for information and browsing on the Internet, in repositories and specialist databases, knows whom to follow in online information sharing and networking places
Exemplified by:	(1) the use of generic web search engines (e.g. Google, Bing, Yahoo etc.), (2) the use of other online	(1) the use of generic and specialist search engines and aggregator portals (e.g. Google Scholar, EBSCO, etc.), (2) the use of specialist online search	(1) the use of generic and specialist search engines and aggregator portals including the use of search filtering (e.g. year, author, title etc.), (2) the use of Boolean logic operators in searches (e.g. AND, OR,

	search mediums (e.g Flickr, Twitter, Facebook, etc.).	mediums (e.g Academia, WolframAlpha, Pubmed Central , Mendeley etc.).	conditioning of search terms), (3) appropriate and effective use of online networking technologies (e.g. LinkedIn, Slideshare, Yammer etc.).
INFORMATION MANAGEMENT	Saves or stores files in different formats and content; retrieves saved content	Saves, stores, tags content and information, creates one's own personal storing strategy, retrieves and manages information and content previously saved or archived	Applies different methods and tools to organise files, content and information, deploys a set of varied strategies for retrieving and managing the content having been organised and stored; uses referencing software
Exemplified by:	(1) the use of file explorer to store and retrieve files, (2) the use of bookmarking functionality to save internet addresses.	(1) the use of file explorer to store and retrieve files including usage of folders to organise information, (2) the use of bookmarking functionality including folders and tagging to organise internet addresses.	(1) the use of multiple tools and strategies to manage information , (2) the use of bookmarking , tagging and feeds to manage information, (3) the use of multiple search functions and strategies to retrieve the correct information with minimal effort, (4) the use of referencing software (e.g. Mendeley, RefMe, RefWorks and EndNote).
INFORMATION AUTHENTICITY	Recognises the difference in authenticity of information sources	Compares a variety of different information sources	Is critical about the information found, cross-checks and assesses its validity and credibility, filters and monitors the information received
Exemplified by:	(1) the use of search engines and terms appropriate to the required authenticity of the task (e.g. Google search, World Bank, OECD, NHS, UK GOV etc.).	(1) the use of search engines and terms to triangulate information and check the validity, (2) the ability to assess at a glance the likelihood of getting valid information by looking at the search result summaries.	(1) the critical evaluation and triangulation of search-engine results to assess the validity of retrieved information, (2) the use of filtering functionalities, techniques and strategies to assess the authenticity of the information according to the requirements of the task.

Communication			
A graduate is able to communicate and collaborate effectively using a variety of digital tools including actively and appropriately participating in online communities and networks.			
• **A learner interacts with others using basic features of communication tools; understands basic behaviour norms that apply when using digital tools to communicate with others; shares files and content with others through basic technological means; knows that technology can be used to interact with services and passively uses some; collaborates with others using basic technologies; is aware of the benefits and risks related to digital identity.** • **An intermediate user uses several more advanced features of online communication tools to interact with others; knows the principles of online etiquette and applies them in a variety of contexts; participates in social networking sites and online communities sharing knowledge, content and information; uses basic features of online services; creates and discusses outputs in collaboration with others who use simple digital tools; shapes their online digital identity and keeps track of their digital footprint.** • **An advanced user engages in the use of a wide range of tools for online communication; applies the various aspects of online etiquette to different digital communication spaces and contexts; develops strategies to identify inappropriate behaviour; adopts digital modes and ways of communication that are fit for purpose; tailors the format and ways of communication to suit the audience; manages the different types of received communication; actively shares information, content and resources with others through online communities, networks and collaboration platforms; actively engages in online participation using several online services; frequently and confidently uses several digital collaboration tools and means to collaborate with others in the production and sharing of resources, content and knowledge; manages several digital identities according to the context and purpose; monitors the information and data produced through online interactions and protects their digital reputation.**			
Badge	**Learner**	**Intermediate**	**Advanced**
COMMUNICATION EXCHANGE	Uses basic features of communication tools	Uses several digital tools to interact with others using more advanced features of communication tools	Manages efficiently the different types of received communication, uses appropriately and purposefully a wide range of tools for online communication, and tailors the format and ways of communication to the audience
Exemplified by:	(1) the use of basic functions of email, instant messaging, online	(1) the use of advanced functions of email (search, filtering and automated rules),	(1) the purposeful and efficient use of the advanced functions of email, instant

	video conferencing, social networks, blogs, etc. (e.g. Outlook, Webmail, AIM, Skype, LinkedIn, Google Chat Hangouts, Blogger, etc.).	instant messaging (e.g. use of groups, multiway chat and archiving conversations), online videoconferencing (e.g. use of groups, shared desktop, and recording of the session), social networks (e.g. customising privacy settings, managing the visibility of information and creating engaging profiles), blogs (e.g. managing security settings, customising the layout and colour scheme and recruiting audience to increase readership).	messaging, online videoconferencing, social networks, blogs, etc. (e.g. Outlook, Webmail, AIM, Skype, LinkedIn, Google Chat Hangouts, Blogger, etc.), (2) the efficient management of information by use of prioritisation, filtering and techniques appropriate to the task, (3) the customisation of communication messages to match the needs of the audience.
COMMUNICATION COLLABORATION	Shares files and content using basic, digital technologies	Creates and discusses outputs in collaboration with others using basic online digital tools	Frequently and confidently uses several digital collaboration tools and means to collaborate with others in the production and sharing of resources, knowledge and content
Exemplified by:	(1) the use of email attachments, network drives, cloud storage services and portable storage devices (e.g. Outlook, Webmail, One Drive, Google Drive, Drop Box, USB flash drive, portable hard disks, flash storage cards etc.).	(1) the use of online tools to communicate, collaborate and share digital artefacts (e.g. Outlook, Webmail, One Drive, Google Drive, Drop Box, SharePoint, Wikis and Blogs, etc.).	(1) the use of a variety of online tools to effectively communicate and collaborate in the co-authoring of digital artefacts (e.g. Microsoft Office 365, Google Applications, Microsoft SharePoint, Wikis and Blogs, etc.).
COMMUNICATION NETWORKING	Is aware of networking sites as well as of the online behaviour norms	Knows the principles of online etiquette and applies them in a variety of contexts, participates actively in networking sites and online communities	Applies the various aspects of online etiquette to different digital communication spaces and contexts, develops strategies to deal with and minimise inappropriate behaviour, actively engages in online participation through a variety of

			appropriate online communities and networks
Exemplified by:	(1) demonstrates awareness of social and professional online networking websites and applications (e.g. Facebook, LinkedIn, Google Circles, XING, Twitter, Meetup etc.).	(1) awareness and ability to demonstrate online behaviours and etiquette (e.g. neutrality, writing style and tone, online bullying, trolling etc.), (2) participation and contribution to the online networks of choice.	(1) application of appropriate online behaviour and etiquette (e.g. maintain neutrality, use of appropriate writing style and tone, avoidance of aggressiveness and online bullying, avoidance of trolling etc.), (2) active participation as a contributor to a range of online networks.
COMMUNICATION PERSONA	Is aware of their digital identity and online footprints	Shapes their online digital identity and keeps track of their digital footprint	Proactively manages several digital identities according to the context and purpose, monitors the information and data produced through online interactions, protects their digital reputation
Exemplified by:	(1) demonstrated awareness of the consequences of their online actions and digital traces (e.g. differentiating private from professional online engagement, awareness of online activity tracking, difficulties with implementing the '*right to be forgotten*' etc.).	(1) management of online identity (e.g. handling of private and professional identities, acknowledging the difficulties in implementing the '*right to be forgotten*', etc.), (2) monitoring and managing digital traces (e.g. using private browsing, browser sandboxing applications, use of anonymous networks like TOR, etc.).	(1) proactive management of multiple online identities (e.g. handling of multiple private and professional identities), (2) monitoring and managing digital traces (e.g. using private browsing, browser sandboxing applications, use of anonymous networks like TOR, etc.), (3) protecting their digital identity and reputation (e.g. use of multiple identities, use of aliases, acknowledgement of dangers and protection of online reputation through vigilance, etc.)

Content Creation			
A graduate is able to edit, create and repurpose digital content, using a variety of software solutions. A graduate recognises the importance of the media, message alignment and the correct application of intellectual property rights and licences.			
• **A <u>learner</u> user: produces simple digital content in different media formats; makes basic changes to the content that others have produced; modifies content using basic functions of applications; knows that online content is covered by copyright.** • **An <u>intermediate</u> user: produces digital content in different formats; edits, refines and modifies the content produced; has basic knowledge of the differences between copyright, copyleft and creative commons and applies some licences to the created content; applies several modifications to software and applications; has a basic understanding of copyright and intellectual property right.** • **An <u>advanced</u> user: produces digital content in different formats, platforms and environments; uses a variety of digital tools for creating original multimedia outputs; mashes-up existing items of content to create new ones; knows how different types of licences apply to the information and resources used or created; customises with (open) programmes, modifies, changes or authors computer code in several programming languages; understands the systems and functions that are behind programmes.**			
Badge	**Learner**	**Intermediate**	**Advanced**
ARTEFACT CREATION	Produces and edits existing basic digital content	Produces digital multimedia content in a variety of formats; edits, refines and modifies existing content	Produces digital content in different formats, platforms and environments, uses a variety of digital tools to create original multimedia outputs, mashes-up existing content items to create new ones
Exemplified by:	(1) the use of content-authoring applications to produce or edit basic digital artefacts (e.g. typesetting, digital photography, mind mapping, etc.).	(1) the use of content- authoring applications to produce, modify and refine multimedia content in a variety of formats (e.g. typesetting, digital videography, animation, etc.).	(1) the efficient use of content- authoring applications to produce, modify and refine original multimedia content in a variety of formats and platforms (e.g. professional grade applications for typesetting, digital photography and videography, animation, etc.).
INTELLECTUAL PROPERTY	Is aware of copyright and intellectual property rights	Has basic knowledge of the terms copyright, copyleft, creative commons	Knows how different types of licences apply to the information and resources they use and create, keeps up-

		and applies some licences to the created content	to-date with intellectual property developments, actively engages with or supports open programmes
Exemplified by:	(1) awareness of the intangible property that is the result of creativity (e.g. patents, copyrights, etc.).	(1) rudimentary knowledge of terminology and the processes used to ascertain intellectual property (e.g. patents, copyrights, etc.), (2) the application of licences (e.g. creative commons, trademarks, etc.).	(1) understanding of the different types of licences that can be applied to intellectual property (e.g. patents, copyrights, trademarks etc.), (2) proactive monitoring of developments in intellectual property law or attending of formal training, (3) supporting or contributing to intellectual property programmes (e.g. open intellectual property initiatives)
MESSAGE	Constructs simple messages that are mostly factual in nature	Constructs clear messages that are the result of analysis and synthesis from a variety of sources	Constructs messages that contain compelling arguments and are the result of critical analysis and synthesis from a variety of appropriate and reputable sources
Exemplified by:	(1) the use of digital systems to disseminate information (e.g. posting on social networks, communicating via email or instant messaging, etc.).	(1) the use of digital systems to communicate messages that contain a level of analysis and synthesis (e.g. presentations, blog posts, posting on professional forums etc.).	(1) the use of digital systems to communicate messages that are well-argued, referenced, critically analysing a topic and synthesising ideas and information from appropriate and trustworthy sources (e.g. publication of e-books, articles in journals, professional newsletters, blogs, etc.).

Safety			
A graduate is able to protect their own information and devices by using appropriate security measures, is aware of privacy issues, knows how and for what purposes the data is collected, protects own digital identity and ensures that digital technology is used in a safe and sustainable way.			
• **A learner user: takes basic steps to protect own devices; knows that only certain types of information about one's self or others should be shared in online environments; knows how to avoid cyber bullying; knows that technology can affect health if misused; takes basic measures to save energy.** • **An intermediate user: knows how to protect their own digital devices and update security strategies; protects their own and others online privacy; has a general understanding of privacy issues and basic knowledge on how data is collected and used; knows how to protect one's self and others from cyber bullying; understands health risks associated with the use of technologies; understands the positive and negative aspects of the use of technology on the environment.** • **An advanced user: frequently updates their own security strategies; takes action when the device is under threat; often changes the default privacy settings of online services to enhance privacy protection; has informed and wide understanding of privacy issues and knows how data is collected and used; is aware of the correct use of technologies to avoid health problems; knows how to balance between online and offline worlds; has an informed stance of the impact of technologies on everyday life, online consumption, and the environment.**			
Badge	**Learner**	**Intermediate**	**Advanced**
DEVICE SECURITY	Takes basic steps to protect own devices	Knows what measures to take to protect own devices, has a personalised protection strategy tailored to own usage patterns and keeps it up-to-date	Keeps up-to-date with the latest threats and establishes counter-measures to protect own devices, frequently reviews and updates the personal protection plan according to current threats, reviews and amends the default privacy settings of online services to enhance privacy protection
Exemplified by:	(1) the use of access control mechanisms (e.g. passwords, pattern locks, fingerprint scans, etc.).	(1) knowledge on how to protect digital devices (e.g. use of strong passwords, anti-virus software, firewalls, etc.), (2) a tailored protection strategy based on the specific usage-patterns (e.g. identify threats such as	(1) proactive monitoring of recent threats and action taken to ensure digital device safety, (e.g. updating applications and operating systems, systematically and frequently running security scans, etc.), (2) a

		‘phishing’ attempts, adapt online behaviour according to risk factors, etc.)	frequently updated personalised protection strategy (e.g. identify recent threats, regularly review the risk factors and adapt online behaviour accordingly, etc.), (3) systematically adjusts the privacy and security settings of applications and online services, (e.g. disallows automatic collection of personal information, uses explicit rules to restrict privileges within a firewall, uses non-administrative accounts for everyday use, etc.)
DATA PROTECTION	Has a general understanding of what information to share in online environments is	Is aware of online privacy issues and has basic knowledge of how data is collected and used by service providers	Has informed and wide understanding of privacy issues, knows how data is collected, triangulated, shared and used by service providers and third parties
Exemplified by:	(1) awareness of the types of information that could be safely shared online (e.g. being aware of the openness and permanency of online information, applies discretion when using a variety of services in respect to the style and content of communication, etc.).	(1) understanding of how to protect their privacy online (e.g. adjusting the privacy settings, selectively sharing personal information, etc.), (2) awareness of the types of personal data collected and retained by service providers, (e.g. tracking activity and user behaviour, internet browser ‘cookie’ management, web traffic monitoring, filtering and management, etc.).	(1) in-depth understanding of privacy issues (e.g. systematic adjustment of privacy settings, understanding of the terms and conditions of using online services, etc.), (2) protecting online privacy by taking steps to minimise the risks, (3) understanding the types of personal data collection, processing and use by service providers and third parties (e.g. tracking activity and user behaviour, internet browser ‘cookie’ management, web traffic monitoring, filtering and management, etc.).

SUSTAINABILITY	Is aware of the environmental impact of technology, takes basic measures to save energy	Understands the positive and negative aspects of the use of technology on the environment, takes measures to use technologies sustainably	Has an informed stance on the impact of technologies on everyday life, online consumption, and the environment; proactively takes measures to use technologies sustainably
Exemplified by:	(1) awareness of the environmental consequences of technology use (e.g. carbon emissions, electronic waste, manufacturing pollution, etc.), (2) taking measures to reduce energy, (e.g. electricity smart meters, powering off instead of using standby mode, smart switches, etc.)	(1) understanding of the environmentally beneficial and detrimental uses of technology (e.g. use of videoconferencing to reduce travel, digitisation reducing demands on paper, waste management, etc.), (2) using technologies sustainably, (e.g. recycle or donate unused electronic devices, etc.)	(1) demonstration of awareness about the contemporary issues of technology use in all areas of life including digital consumption, sustainability and environmental implications, (2) actively practicing and promoting sustainable uses of technology, (e.g. reducing power consumption, electronic waste management, etc.)
PHYSICAL & MENTAL SAFETY	Knows that technology can affect their health if used inappropriately, knows how to avoid cyber bullying	Understands the health risks associated with the use of technologies, knows how to protect themselves and others from cyber bullying	Practices the correct use of technologies to avoid health problems, has a balanced attitude towards technology, actively ensures the wellbeing of themselves and others when engaging with technologies
Exemplified by:	(1) awareness of the health implications of technology-use (e.g. posture, lighting, hand rest, online addiction, etc.), (2) awareness of online social threats and how to avoid them (e.g. bullying, harassment, 'trolling' etc.).	(1) the ability to demonstrate knowledge and understanding of the health implications of technology-use (e.g. adjusting posture, use of appropriate lighting, hand rest, taking steps to avoid online addiction, etc.), (2) the ability to demonstrate knowledge and understanding of online social threats and how to avoid them, including ways meant for the protection of others (e.g. using filtering to block and scrutinise communications,	(1) the appropriate use of technology for the protection of own and the others' health (e.g. ensure comfortable and correct posture, use of appropriate lighting, foot rest, ability to recognise signs of avert online addiction, etc.), (2) the demonstration of sensible and appropriate attitudes towards technology (e.g. appropriate utilisation of technology according to the task, is not over depended nor indifferent towards technology, etc.), (3) proactive safeguarding

		reporting inappropriate behaviour, supporting others, etc.).	of the physical and mental wellbeing of one's self and others when using technology (e.g. physically engaging with technology in a safe manner, moderate online communications, reporting inappropriate behaviour, etc.).

Problem Solving			
A graduate is able to make informed decisions on the appropriateness of digital tools for carrying out a task according to the purpose or needs, solve technical and conceptual problems through digital means, identify resources and update one's own competences as required.			
• **A <u>learner</u> user: asks for targeted support and assistance when technologies do not work or when using a new device, programme or application; uses some technologies to solve routine tasks; makes decisions when choosing a digital tool for a routine practice; knows that technologies and digital tools can be used for creative purposes and makes creative use of technologies to a certain extent; is aware of own limits when using technologies.** • **An <u>intermediate</u> user: solves simple problems that arise when technologies do not work; understands what technology can do for a user and what it cannot; solves a non-routine task by exploring technological possibilities; selects an appropriate tool according to the purpose and evaluates its effectiveness; uses technologies for creative outputs and to solve problems; collaborates with others for the creation of innovative outputs but does not usually take the initiative; knows how to learn to do something new with technologies.** • **An <u>advanced</u> user: solves a wide-range of problems that arise from the use of technology; makes informed decisions when choosing a tool, device, application, software or service for a non-familiar task; is aware of new technological developments; understands how new tools work and operate; critically evaluates which tool best serves the purpose; solves conceptual problems by taking advantage of technologies and digital tools; contributes to knowledge creation through technological means; participates in innovative actions through the use of technologies; proactively collaborates with others to produce creative and innovative outputs; frequently updates own digital competences.**			
Badge	**Learner**	**Intermediate**	**Advanced**
TROUBLESHOOTING	Uses technologies to solve some typical tasks, makes decisions when choosing a digital tool for everyday practice	Understands the affordances of technology, selects a tool according to its appropriateness for the purpose and evaluates its effectiveness, is somewhat aware of new technological developments, solves a non-routine task by exploring technological possibilities	Makes informed decisions when choosing a tool, device, application, software or service for a non-familiar task, is aware of new technological developments, understands how new tools work and operate, critically evaluates which tool serves the purpose best, solves conceptual problems taking advantage of technologies and digital tools
Exemplified by:	(1) the ability to utilise technology in solving conventional tasks (e.g. word processing a letter, using digital	(1) the ability to demonstrate understanding of the advantages and disadvantages of technological systems	(1) the making of educated choices when selecting technologies for unfamiliar tasks (e.g. selecting a suitable, new referencing

	repositories, using online forms etc.), (2) the ability to make simple decisions in selecting a digital tool for carrying out a task (e.g. using webmail instead of email client, using an application for currency conversion instead of an online service, etc.).	(e.g., online versus offline solutions, portability versus usability, etc.), (2) the ability to recommend tools appropriate for specialised tasks and evaluate their performance (e.g. use specialist translation software, use online revision tools, etc.), (3) the ability to utilise technology in solving intricate tasks (e.g. use Spreadsheet calculations to analyse and visualise data, securely share documents with groups of people and appropriately manage access restrictions, etc.).	application from a number of alternatives, choosing and using an online team collaboration service, etc.), (2) keeping up-to-date with technological developments and appreciating how new technologies function (e.g. reading technology news and blogs, understanding the basic principles of how digital technologies work, etc.), (3) the ability to critically assess technological systems and tools for their suitability to some specific need (e.g. evaluate the suitability of online collaboration platforms, critically review a variety of tablet devices of differently operating systems, etc.), (4) finding solutions to abstract questions by utilising technological systems and tools (e.g. using advanced modelling to predict outcomes of complex systems, using visualisations to map and display complex or speculative systems, etc.)
CREATIVITY	Knows that technologies and digital tools can be used for creative purposes and makes use of these	Uses technologies for creative outputs, solves a variety of problems, collaborates with others for the creation of innovative outputs	Contributes to knowledge creation through technological means, participates in innovative actions through the use of technologies, proactively collaborates with others to produce creative and innovative outputs
Exemplified by:	(1) awareness of the creative potential of digital technologies including some limited usage (e.g. digital photography	(1) utilisation of technologies to solve problems or produce creative artefacts (e.g. general office administration, producing circular newsletters, etc.), (2) collaborating in the production of new	(1) contributing to knowledge facilitated by technology (e.g. publishing on online platforms such as blogs, journals or forums, etc.), (2) engaging with novel initiatives in the use of technology (e.g. use of technology in

	or videography, publishing of literary works, articles, books, etc.)	and creative outputs through the use of technology (e.g. leveraging online 'cloud' services to collaborate, co-authoring or editing creative artefacts, etc.).	artistic and social actions, participating in activist initiatives facilitated by technology, etc.), (3) proactively collaborating in the production of new and creative outputs through the use of technology (e.g. leveraging online 'cloud' services to collaborate, co-authoring or editing creative artefacts, etc.).
SELF-SUFFICIENCY	Asks for targeted support and assistance when technologies do not work or when using a new device, programme or application; possesses some basic knowledge but is aware of own limits	Solves simple problems that arise when technologies do not work, knows how to learn to do new things through the aid of technologies	Solves a wide-range of problems that arise from the use of technology, knows how to acquire new technological skills and where to look for information
Exemplified by:	(1) elementary ability to identify a problem through the means of technology and awareness of the available support options (e.g. has the ability to identifying technology malfunctions, knows who to contact when things go wrong, etc.), (2) entry-level technological knowledge and ability to troubleshoot (e.g. able to differentiate simple hardware and software issues, able to describe in sufficient detail the problem when contacting for support, basic understanding of terminology, etc.).	(1) ability to troubleshoot and solve simple technological problems (e.g. setting up and accessing consumer grade WiFi and network connections, able to change the default printer or manage the printing properties, etc.), (2) ability and willingness to learn how to use new technologies (e.g. looking up online instructions on how to use advanced formatting options in a word processor, discovering how to install or uninstall applications, etc.)	(1) ability and willingness to troubleshoot, investigate and solve a variety of complex technological problems (e.g. knowing how to investigate issues and where to look for relevant information, willingness to try out different solutions, etc.), (2) ability and willingness to seek information when presented with a technical difficulty including the ability to carry out investigations at the necessary level of detail when seeking help from more experienced members of a support community (e.g., troubleshooting, researching information, trying things out, seeking help, reporting results, applying suggested procedures, etc.).

The digital literacy definitions are adaptations based on Ferrari's (2013) EU Digital Competence (DIGCOMP) framework specification.

References

Ferrari, A., 2013. *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*. [online] Luxembourg: Publications Office of the European Union. Available at: <http://ftp.jrc.es/EURdoc/JRC83167.pdf>.

Appendix 18 - TOOL_06 Digital Literacy Framework (Online Badges)

FINDING, USING AND MANAGING INFORMATION			
An individual is able to undertake digital searches and manage information, critically evaluate the authenticity of the source, recognise the importance of the different types of digital source material and use it ethically.			
BADGE	Beginner	Intermediate	Advanced
INFORMATION SEARCH			
	Searches the internet through search engines	Searches the Internet and other digital repositories for information; selects only appropriate information	Utilises a wide range of strategies when searching for information and browsing on the Internet, in repositories and specialist databases, knows whom to follow in online information sharing and networking places
INFORMATION MANAGEMENT			
	Saves or stores files in different formats and content; retrieves saved content	Saves, stores, tags content and information, creates one's own personal storing strategy, retrieves and manages information and content previously saved or archived	Applies different methods and tools to organise files, content and information, deploys a set of varied strategies for retrieving and managing the content having been organised and stored; uses referencing software

INFORMATIO N AUTHENTICIT Y			
	Recognises the difference in authenticity of information sources	Compares a variety of different information sources	Is critical about the information found, cross-checks and assesses its validity and credibility, filters and monitors the information received

WORKING IN THE DIGITAL AGE			
An individual is able to communicate and collaborate effectively using a variety of digital tools including actively and appropriately participating in online communities and networks.			
BADGE	Beginner	Intermediate	Advanced
COMMUNICATION			
	Uses basic features of communication tools	Uses several digital tools to interact with others using more advanced features of communication tools	Manages efficiently the different types of received communication, uses appropriately and purposefully a wide range of tools for online communication, and tailors the format and ways of communication to the audience
MESSAGING OTHERS			
	Constructs simple messages that are mostly factual in nature	Constructs clear messages that are the result of analysis and synthesis from a variety of sources	Constructs messages that contain compelling arguments and are the result of critical analysis and synthesis from a variety of appropriate and reputable sources

COLLABORATIO N			
	Shares files and content using basic, digital technologies	Creates and discusses outputs in collaboration with others using basic online digital tools	Frequently and confidently uses several digital collaboration tools and means to collaborate with others in the production and sharing of resources, knowledge and content
NETWORKING			
	Is aware of networking sites as well as of the online behaviour norms	Knows the principles of online etiquette and applies them in a variety of contexts, participates actively in networking sites and online communities	Applies the various aspects of online etiquette to different digital communication spaces and contexts, develops strategies to deal with and minimise inappropriate behaviour, actively engages in online participation through a variety of appropriate online communities and networks

DIGITAL PERSONA			
	Is aware of their digital identity and online footprints	Shapes their online digital identity and keeps track of their digital footprint	Proactively manages several digital identities according to the context and purpose, monitors the information and data produced through online interactions, protects their digital reputation

CREATING DIGITAL CONTENT			
An individual is able to edit, create and repurpose digital content, using a variety of software solutions. An individual recognises the importance of the media, message alignment and the correct application of intellectual property rights and licences.			
BADGE	Beginner	Intermediate	Advanced
ARTEFACT CREATION			
	Produces accessible and edits existing basic digital content	Produces accessible digital multimedia content in a variety of formats; edits, refines and modifies existing content	Produces accessible digital content in different formats, platforms and environments, uses a variety of digital tools to create original multimedia outputs, mashes-up existing content items to create new ones
INTELLECTUAL PROPERTY			
	Is aware of copyright and intellectual property rights	Has basic knowledge of the terms copyright, copyleft, creative commons and applies some licences to the created content	Knows how different types of licences apply to the information and resources they use and create, keeps up-to-date with intellectual property developments, actively engages with or supports open programmes

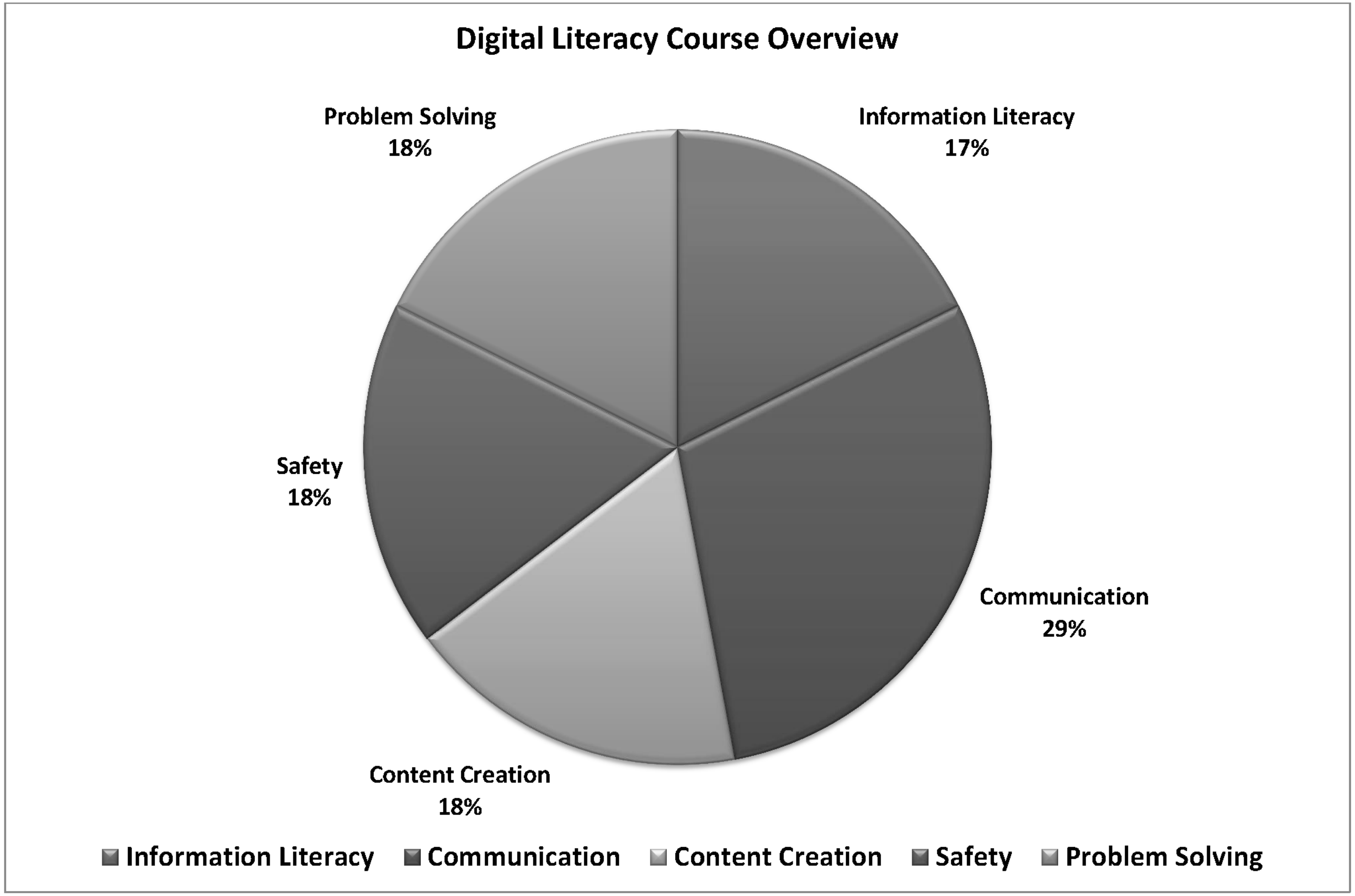
DIGITAL RESPONSIBILITIES			
An individual is able to protect their own information and devices by using appropriate security measures, is aware of privacy issues, knows how and for what purposes the data is collected, protects own digital identity and ensures that digital technology is used in a safe and sustainable way.			
BADGE	Beginner	Intermediate	Advanced
DEVICE SECURITY			
	Takes basic steps to protect own devices	Knows what measures to take to protect own devices, has a personalised protection strategy tailored to own usage patterns and keeps it up-to-date	Keeps up-to-date with the latest threats and establishes counter-measures to protect own devices, frequently reviews and updates the personal protection plan according to current threats, reviews and amends the default privacy settings of online services to enhance privacy protection
SUSTAINABILITY			
	Is aware of the environmental impact of technology, takes basic measures to save energy	Understands the positive and negative aspects of the use of technology on the environment, takes measures to use technologies sustainably	Has an informed stance on the impact of technologies on everyday life, online consumption, and the environment; proactively takes measures to use technologies sustainably

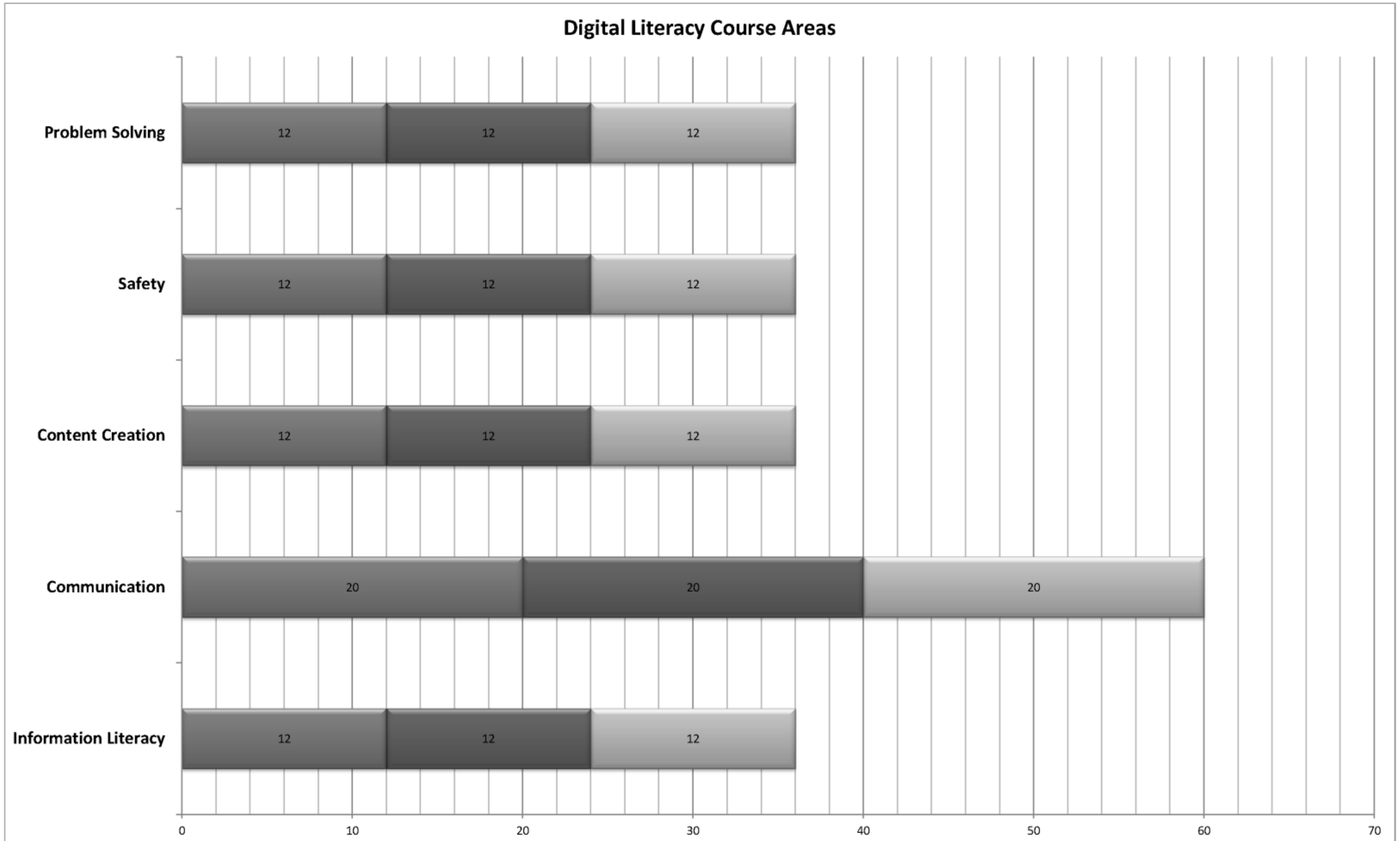
HEALTH & WELLBEING			
	Knows that technology can affect their health if used inappropriately, knows how to avoid cyber bullying	Understands the health risks associated with the use of technologies, knows how to protect themselves and others from cyber bullying	Practices the correct use of technologies to avoid health problems, has a balanced attitude towards technology, actively ensures the wellbeing of themselves and others when engaging with technologies
DATA PROTECTION			
	Has a general understanding of what information to share in online environments is	Is aware of online privacy issues and has basic knowledge of how data is collected and used by service providers	Has informed and wide understanding of privacy issues, knows how data is collected, triangulated, shared and used by service providers and third parties

PROBLEM SOLVING IN THE DIGITAL WORLD			
An individual is able to make informed decisions on the appropriateness of digital tools for carrying out a task according to the purpose or needs, solve technical and conceptual problems through digital means, identify resources and update one's own competences as required.			
BADGE	Beginner	Intermediate	Advanced
TROUBLESHOOTING			
	Uses technologies to solve some typical tasks, makes decisions when choosing a digital tool for everyday practice	Understands the affordances of technology, selects a tool according to its appropriateness for the purpose and evaluates its effectiveness, is somewhat aware of new technological developments, solves a non-routine task by exploring technological possibilities	Makes informed decisions when choosing a tool, device, application, software or service for a non-familiar task, is aware of new technological developments, understands how new tools work and operate, critically evaluates which tool serves the purpose best, solves conceptual problems taking advantage of technologies and digital tools
CREATIVITY			
	Knows that technologies and digital tools can be	Uses technologies for creative outputs, solves a variety of problems, collaborates with others	Contributes to knowledge creation through technological means, participates in innovative

	used for creative purposes and makes use of these	for the creation of innovative outputs	actions through the use of technologies, proactively collaborates with others to produce creative and innovative outputs
SELF-SUFFICIENCY			
	Asks for targeted support and assistance when technologies do not work or when using a new device, programme or application; possesses some basic knowledge but is aware of own limits	Solves simple problems that arise when technologies do not work, knows how to learn to do new things through the aid of technologies	Solves a wide-range of problems that arise from the use of technology, knows how to acquire new technological skills and where to look for information

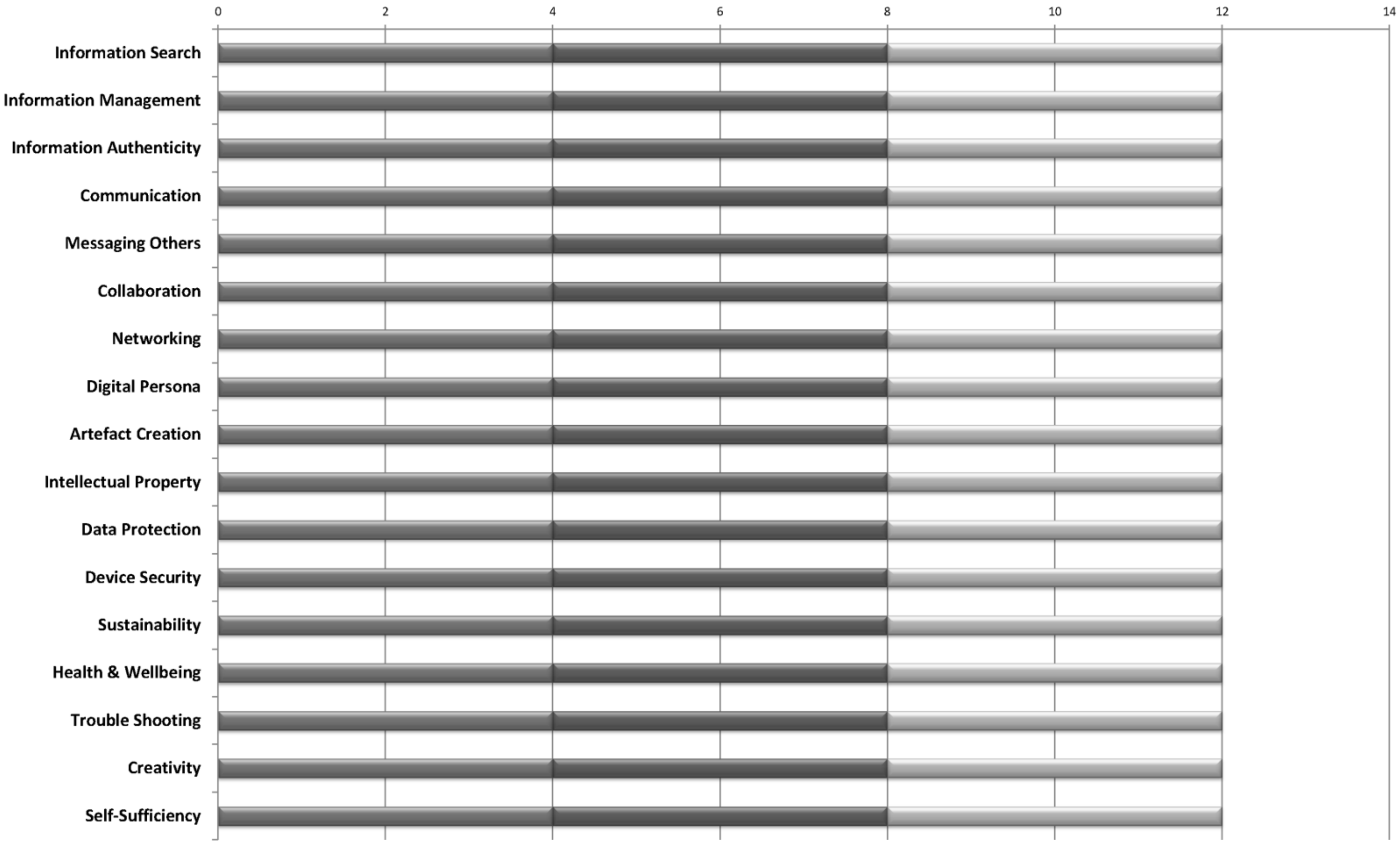
Appendix 19 - TOOL_07 DL Curriculum Mapping Toolkit


Digital Literacy Course Overview
Problem Solving
18%
Information Literacy
17%
Safety
18%
Communication
29%
Content Creation
18%
Information Literacy
Communication
Content Creation
Safety
Problem Solving



	Information Literacy	Communication	Content Creation	Safety	Problem Solving
Learner	12	20	12	12	12
Intermediate	12	20	12	12	12
Advanced	12	20	12	12	12

Digital Literacy Course Competences



	Self-Sufficiency	Creativity	Trouble Shooting	Health & Wellbeing	Sustainability	Device Security	Data Protection	Intellectual Property	Artefact Creation	Digital Persona	Networking	Collaboration	Messaging Others	Communication	Information Authenticity	Information Management	Information Search
Learner	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Intermediate	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Advanced	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Welcome to the mapping tool for Digital Literacy. It uses the TPAE model, which is: T= Taught, P=Practised, A=Assessed and E=Experienced. For each instance, please use a binary system whereby '1' indicates activity. Starting on the tab labelled 'Information Literacy' insert the module name and codes and then complete the mapping for each Digital Literacy element. Repeart this for all the other tabs. The module information self-propergates. Please overwrite the 'sample' data. This tool is based on work by Dr David Perry and Dr Mark Kerrigan.

Course Information			Learner												Intermediate												Advanced											
In the boxes below, please add the codes of your module and complete the mapping.			**Searching** - Searches the internet through search engines				**Management** - Saves or stores multimedia files and content; retrieves saved content				**Authenticity** - Recognises the difference in authenticity of information sources				**Searching** - Searches the Internet and other digital resources for information; selects only appropriate information				**Management** - Saves, stores, tags content and information, creates one's own personal storing strategy, retrieves and manages information and content previously saved or archived				**Authenticity** - Compares a variety of different information sources				**Searching** - Utilises a wide range of strategies when searching for information and browsing on the Internet, knows whom to follow in online information sharing and networking places				**Management** - Applies different methods and tools to organise files, content and information, deploys a set of varied strategies for retrieving and managing the content having been organised and stored				**Authenticity** - Is critical about the information found, cross-checks and assesses its validity and credibility, filters and monitors the information received			
Level	**Core/Option**	**Module Code**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**
4	**Core**	**MOD000000**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	**Option**	**123456**																																				
6	**Option**	**123456**																																				
Status	**Overall**																																					
Status	**Level 4**																																					
Status	**Level 5**																																					
Status	**Level 6**																																					

Learner

Communication - Uses basic features of communication tools				**Messaging Others** - Constructs simple messages that are mostly factual in nature				**Collaboration** - Shares files and content using simple, traditional, technologies				**Networking** - Is aware of networking sites as well as of the online behaviour norms				**Digital Persona** - Is aware of their digital identity and online footprints			
T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Intermediate

Communication - Uses several digital tools to interact with others using more advanced features of communication tools				**Messaging Others** - Constructs clear messages that are the result of analysis and synthesis from a variety of sources				**Collaboration** - Creates and discusses outputs in collaboration with others using simple online digital tools				**Networking** - Knows the principles of online etiquette and applies them in a variety of contexts, participates in networking sites and online communities as an active contributor				**Digital Persona** - Shapes their online digital identity and keeps track of their digital footprint			
T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Advanced

Communication - Manages efficiently the different types of received communication, uses appropriately and purposefully a wide range of tools for online communication, and tailors the format and ways of communication to suit the audience				**Messaging Others** - Constructs messages that contain compelling arguments and are the result of critical analysis and synthesis from a variety of appropriate and reputable sources				**Collaboration** - Frequently and confidently uses several digital collaboration tools and means to collaborate with others in the production and sharing of resources, knowledge and content				**Networking** - Applied the various aspects of online etiquette to different digital communication spaces and contexts, develops strategies to discover and minimise inappropriate behaviour, actively engages in online participation through a variety of appropriate				**Digital Persona** - Proactively manages several digital identities according to the context and purpose, monitors the information and data produced through online interactions, protects their digital reputation			
T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Course Information			Learner												Intermediate												Advanced											
In the boxes below, please add the codes of your module and complete the mapping.			**Artefact Creation** - Produces and edits existing simple digital content				**Intellectual Properety** - Is aware of intellectual property rights				**Data Protection** - Has a general understanding of what information to share in online environments is				**Artefact Creation** - Produces digital multimedia content in a variety of formats, edits, refines and modifies existing content				**Intellectual Properety** - Has basic knowledge of the terms copyright, copyleft, creative commons and applies some licences to the created content				**Data Protection** - Is aware of online privacy issues and has basic knowledge of how data is collected and used by service providers				**Artefact Creation** - Produces digital content in different formats, platforms and environments, uses a variety of digital tools for creating original multimedia outputs, mashes-up existing items of content to create new ones				**Intellectual Property** - Knows how different types of licences apply to the information and resources they use and create, keeps up-to-date with intellectual property developments, actively engages with or supports open programmes				**Data Protection** - Has informed and wide understanding of privacy issues, knows how data is collected, triangulated, shared and used by service providers and third parties, knows the legal framework that applies to data protection and sources of technical advice			
Level	**Core/Option**	**Module Code**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**	**T**	**P**	**A**	**E**
4	**Core**	**MOD000000**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	**Option**	**123456**																																				
6	**Option**	**123456**																																				
Status	**Overall**																																					

Course Information			Learner											
In the boxes below, please add the codes of your module and complete the mapping.			**Device Security** - Takes basic steps to protect own devices				**Sustainability** - Is aware of the environmental impact of technology, takes basic measures to save energy				**Health & Wellbeing** - Knows that technology can affect their health if misused, knows how to avoid cyber bullying			
Level	Core/Option	Module Code	T	P	A	E	T	P	A	E	T	P	A	E
4	Core	MOD000000	1	1	1	1	1	1	1	1	1	1	1	1
5	Option	123456												
6	Option	123456												
Status	Overall													

Course Information			Intermediate											
In the boxes below, please add the codes of your module and complete the mapping.			**Device Security** - Knows what measures to take to protect own devices, has a personalised protection strategy tailored to own usage patterns and keeps it up-to-date				**Sustainability** - Understands the positive and negative aspects of the use of technology on the environment, takes measures to use technologies sustainably				**Health & Wellbeing** - Understands the health risks associated with the use of technologies, knows how to protect themselves and others from cyber bullying			
Level	Core/Option	Module Code	T	P	A	E	T	P	A	E	T	P	A	E
4	Core	MOD000000	1	1	1	1	1	1	1	1	1	1	1	1
5	Option	123456												
6	Option	123456												
Status	Overall													

Course Information			Advanced											
In the boxes below, please add the codes of your module and complete the mapping.			**Device Security** - Keeps up-to-date with the latest threats and establishes counter- measures to protect own devices, frequently reviews and updates the personal protection plan according to current threats, reviews and amends the default privacy settings of online services to enhance privacy protection				**Sustainability** - as an informed stance on the impact of technologies on everyday life, online consumption, and the environment; proactively takes measures to use technologies sustainably				**Health & Wellbeing** - Practices the correct use of technologies to avoid health problems, has a balanced attitude towards technology, actively ensures the wellbeing of themselves and others when engaging with technologies			
Level	Core/Option	Module Code	T	P	A	E	T	P	A	E	T	P	A	E
4	Core	MOD000000	1	1	1	1	1	1	1	1	1	1	1	1
5	Option	123456												
6	Option	123456												
Status	Overall													

Course Information			Learner												Intermediate												Advanced											
In the boxes below, please add the codes of your module and complete the mapping.			**Trouble Shooting** - Uses technologies to solve some typical tasks, makes decisions when choosing a digital tool for everyday practice				**Creativity** - Knows that technologies and digital tools can be used for creative purposes and makes use of these				**Self-Sufficiency** - Asks for targeted support and assistance when technologies do not work or when using a new device, programme or application; possesses some basic knowledge but is aware of own limits				**Trouble Shooting** - Understands the affordances of technology, selects a tool according to its appropriateness for the purpose and evaluates its effectiveness, solves a non-routine task by exploring technological possibilities				**Creativity** - Uses technologies for creative outputs, solves a variety of problems, collaborates with others for the creation of innovative outputs				**Self-Sufficiency** - Solves easy problems that arise when technologies do not work, knows how to learn to do new things through the aid of technologies				**Trouble Shooting** - Makes informed decisions when choosing a tool, device, application, software or service for a non-familiar task, is aware of new technological developments, understands how new tools work and operate, critically evaluates which tool serves the purpose best, solves conceptual problems taking advantage of technologies and digital tools				**Creativity** - Contributes to knowledge creation through technological means, participates in innovative actions through the use of technologies, proactively collaborates with others to produce creative and innovative outputs				**Self-Sufficiency** - Solves a wide-range of problems that arise from the use of technology, knows how to acquire new technological skills and where to look for information			
Level	Core/Option	Module Code	T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E	T	P	A	E
4	Core	MOD00000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	Option	123456																																				
6	Option	123456																																				
Status	Overall																																					

Appendix 20 - TOOL_08 TELT Pedagogy-Teaching-Learning Alignment

Pedagogies (Beetham, 2013)

Building concepts or competences step-by-step	Achieving understanding through active discovery	Achieving understanding through dialogue and collaboration	Developing practice in a particular community
<u>Theory</u> People learn by association, initially through basic stimulus-response conditioning, later by associating concepts in a chain of reasoning, or associating steps in a chain of activity to build a composite skill. Associativity leads to accuracy of reproduction: for example when safety-critical skills are learned, or factual materials committed to memory. Mnemonics are essentially associative devices. Associative theories are not concerned with how concepts or skills are represented internally, but in how they are manifested in external behaviours, and how different training/instruction regimes manifest themselves in observable learning. However, all formal learning relies to some extent on external evidence (behaviour) as an index of what has been learned. <u>Key Theorists</u> - Skinner - Gagné (Instructivism and Instructional Design) <u>Learning</u> - Routines of organised activity - Progression through component concepts of skills - Clear goals and feedback - Individualised pathways matched to performance <u>Teaching</u> - Analysis into component units - Progressive sequences from component to composite skills or concepts - Clear instructional approach for each unit - Highly focused objectives	<u>Theory</u> People learn by actively exploring the world around them, receiving feedback on their actions, and drawing conclusions. Constructivity leads to integration of concepts and skills into the learner's existing conceptual or competency structures. Learning can be applied to new contexts and expressed in new ways. Experimentation or experiential learning (Kolb's cycle), are typical constructive approaches. Constructive theories are more concerned with how knowledges and skills are internalised than how they are manifest in external behaviour. As in associative approaches, attention will be paid to how learning opportunities are presented so as to allow progressive discovery of relevant concepts/ skills. <u>Key Theorists</u> - Piaget - Papert - Kolb - Biggs <u>Learning</u> - Active construction and integration of concepts - Ill-structured problems - Opportunities for reflection - Ownership of the task <u>Teaching</u> - Interactive environments and appropriate challenges - Encourage experimentation and the discovery of principles - Adapt teaching to existing concepts/skills - Coach and model meta-cognitive skills	<u>Theory</u> Individual discovery of principles is heavily scaffolded by the social environment. Peer learners and teachers play a key role in development by engaging in dialogue with the learner, developing a shared understanding of the task, and providing feedback on the learner's activities and representations. Collaborative work is typical of social constructive approaches. Social constructive theories are concerned with how emerging concepts and skills are supported by others, enabling learners to reach beyond what they are individually capable of (learning in the 'zone of proximal development'). Attention is paid to learners' roles in collaborative activities, as well as the nature of the tasks they undertake. <u>Key Theorists</u> - Vygotsky (Social Development) - Laurillard and Pask (Conversation Theory) <u>Learning</u> - Conceptual development through collaborative activity - Ill-structured problems - Opportunities for discussion and reflection - Shared ownership of the task <u>Teaching</u> - Collaborative environments and appropriate challenges - Encourage experimentation, and shared discovery - Draw on existing concepts/skills - Coach and model skills, including social skills	<u>Theory</u> People learn by participating in communities of practice, progressing from novice to expert through observation, reflection, mentorship, and 'legitimate peripheral participation' in community activities. Like social constructivism situativity emphasises the social context of learning, but this context is likely to be close – or identical – to the situation in which the learner will eventually practice. Work-based learning, continuing professional development, and apprenticeships are typical examples of situated learning. The authenticity of the environment is at least as significant as the support it provides: much less attention is paid to formal learning activities. <u>Key Theorists</u> - Lave and Wenger (Communities of Practice) - Cole, Engeström and Wertsch (Activity Theory) <u>Learning</u> - Participation in social practices of enquiry and learning - Acquiring habits, attitudes, values and skills in context - Developing identities - Developing learning and professional relationships <u>Teaching</u> - Create safe environments for participation - Support development of identities - Facilitate learning - Elaborate authentic opportunities for learning

Approaches to Teaching and Learning (Anglia Ruskin University, 2016 adapted from Sheffield Hallam University's TELT menu)

Lectures as pre-work (a.k.a. 'Flipped Classroom')
Information and lectures provided as pre-work, contact time used for more interactive purposes
Benefits
- Students are able to engage with materials flexibly and at their own pace
- Students come to sessions with a required level of knowledge and understanding
- Allows tutors to repurpose time for more engaging teaching approaches

Indicative Assessment
- In-class tests
- Peer-reviewed presentation
- Practical activities (formative)

Resource-centred or facilitated discussion
Tutors present artefacts and the class undertake self-directed discussion about them. Students might also select the artefact
Benefits
- Encourages expression of feelings, values, opinions and beliefs, and sharing of experiences
- Presentation skills may be practiced, building confidence and the ability for self-expression
- Develops critical evaluation skills

Indicative Assessment
- Demonstrations
- Observation
- Peer-review
- Report

Reflection (including Continuing Personal Development)
Students reflect on practice, experience and their newly developed knowledge and skills
Benefits
- Students have time to consider their development, and can identify areas of personal challenge
- The ability to reflect on actions and decisions is a necessary skill in many occupation and in professional body requirements
- Helps students to develop critical-thinking and writing skills

Indicative Assessment
- Commentary
- Critical reflection
- Development plan
- Portfolio
- Reflective essay
- Situational analysis (SWOT)
- Verbal reflection
- Viva

Phased learning (a.k.a. 'Mastery')
Students required to fully understand a concept, skill or technique before moving on to more advanced topics
Benefits
- Moving onto more complex topics, making learning more visible to students
- Student is encouraged to become more autonomous
- Develops students' confidence in their abilities

Indicative Assessment
- Lab reports
- Observations
- Repeatable (randomised), formative tests

Critiquing
Students critique each other's work or that of a third party and provide advice on improvements
Benefits
- Helps develop skills in critical thinking, evidencing and evaluation in respect of own and others' work
- Supports development of reflective capability
- Students receive richer feedback on how to improve their work based on multiple perspectives

Indicative Assessment
- Critical essay
- Staged development of artefact with reflection on peer criticism

Debate
Students are given a fairly controversial topic to research and discuss, developing their understanding
Benefits
- Develops high-level communication skills and confidence
- Builds skills necessary in employment, e.g. supporting a personal point of view, advocating on behalf of others, or playing 'Devil's Advocate'
- Stimulates and engages students by challenging existing beliefs

Indicative Assessment
- Blogs or discussion forum, with position post and related discussion
- Observation
- Peer-review
- Report

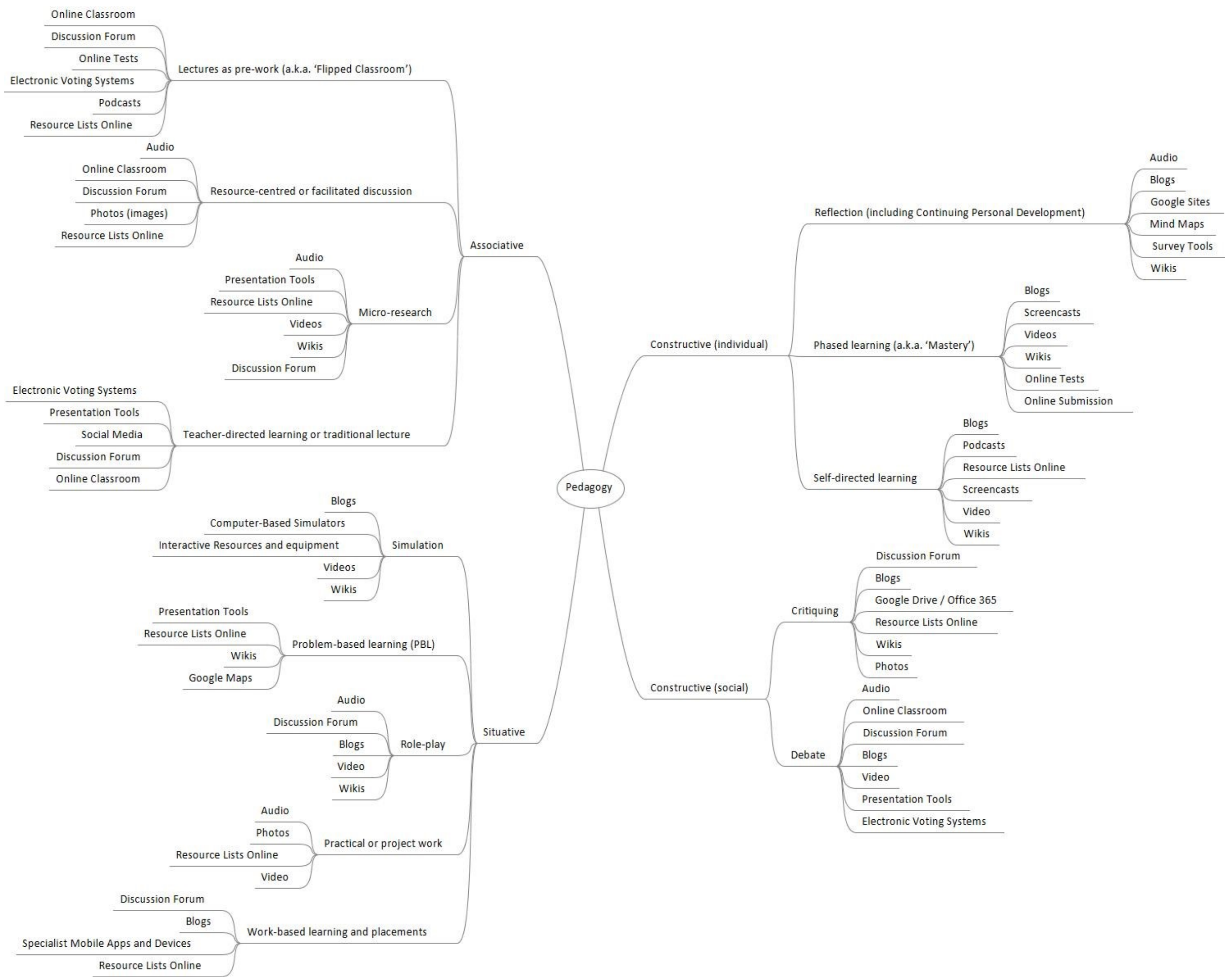
Simulation
Real-world situations are investigated using tools and methods as close as possible to those in the workplace
Benefits
- Facilitate and encourage practical skill and equipment proficiencies likely to be encountered in practice
- Modelling the 'real world' allows better understanding of the relevant concepts
- Allows 'safe' exploration of challenging or controversial topics and techniques

Indicative Assessment
- Competency tests
- Examination
- Modelling
- Observation
- Reflective writing

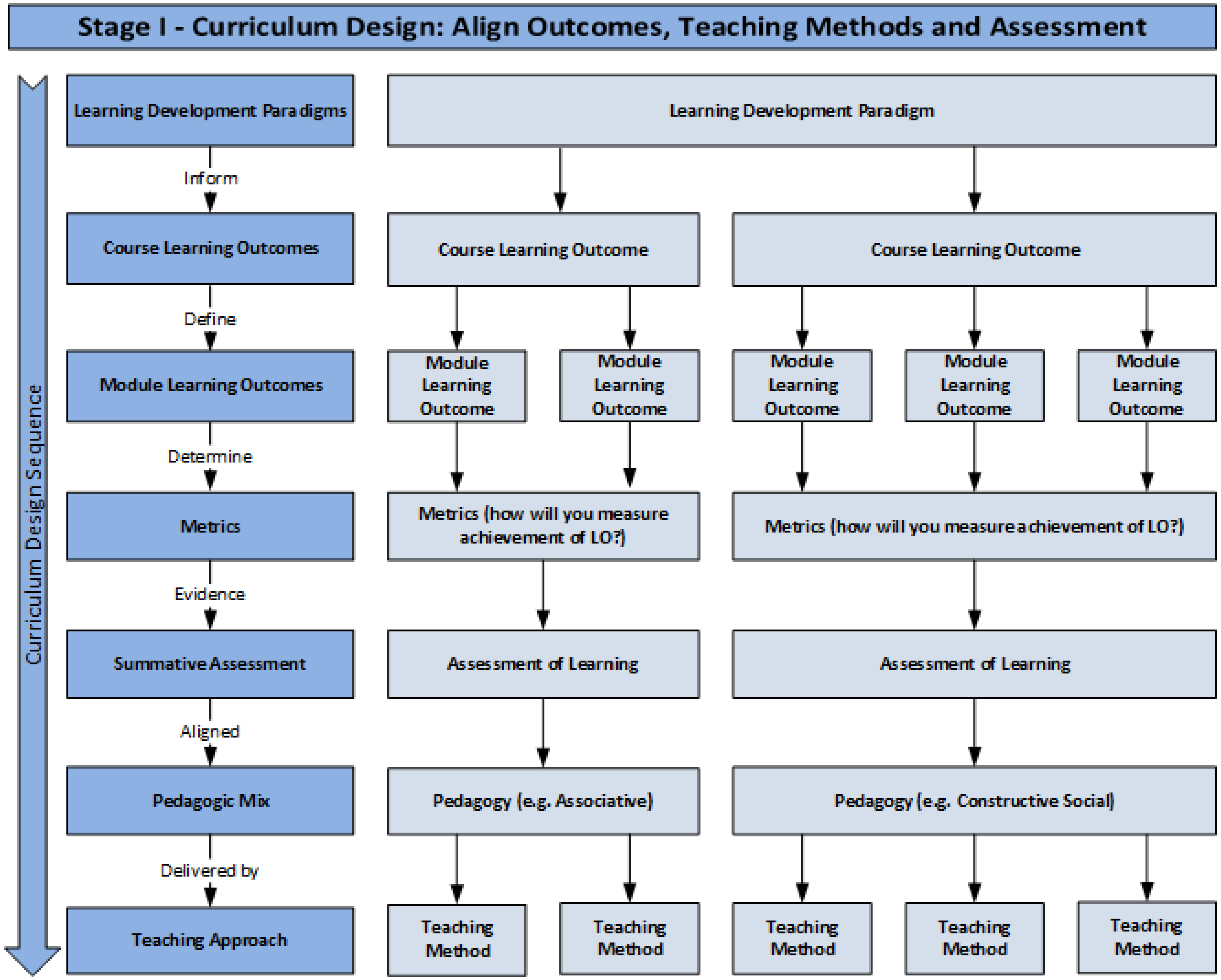
Problem-based learning (PBL)
Students are challenged to solve real world problems, often those without a single right answer, helping develop critical thinking skills
Benefits
- Encourage and enable imaginative and innovative thinking
- Provides students with the opportunity to research and evaluate the relative merits of different approaches

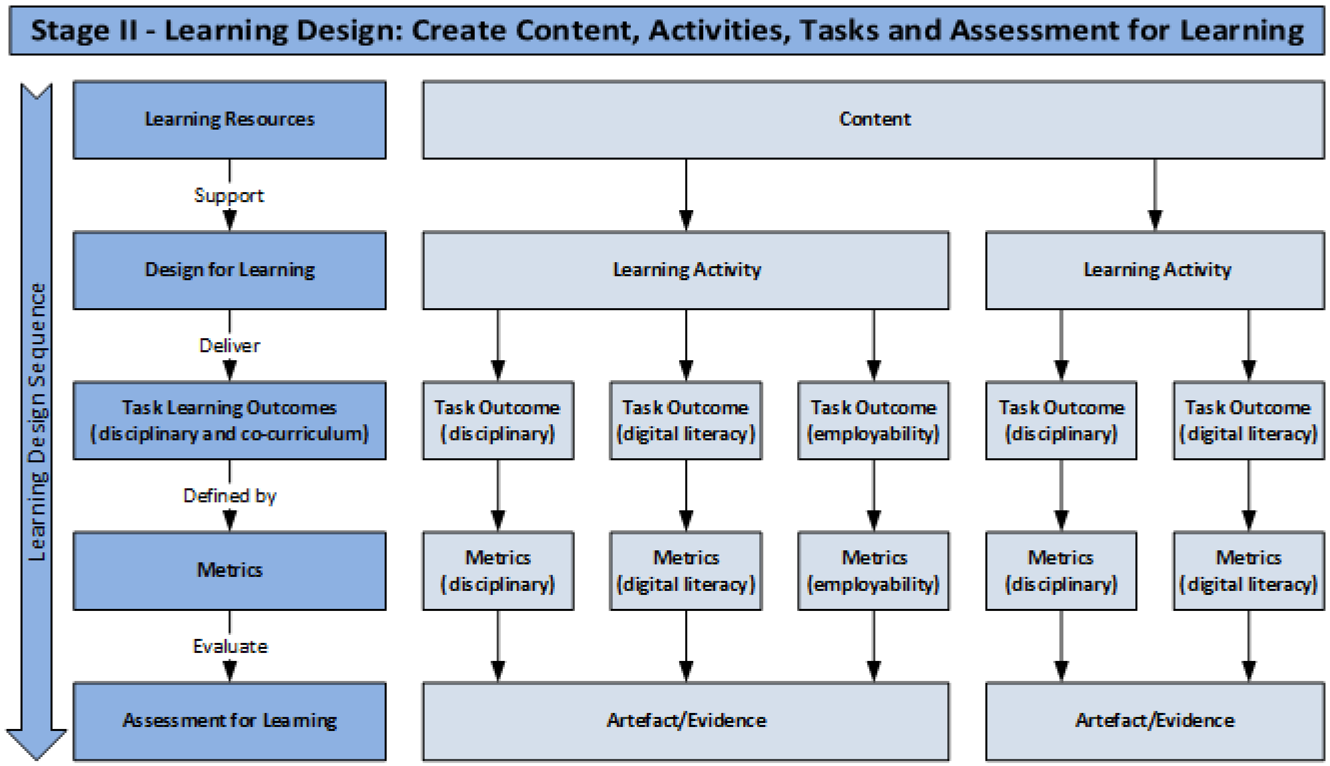
Indicative Assessment
- Practical examination
- Presentation
- Problem solving
- Report
- Solution

Appendix 21 - TOOL_09 TELT Pedagogy-Teaching-Technology Alignment

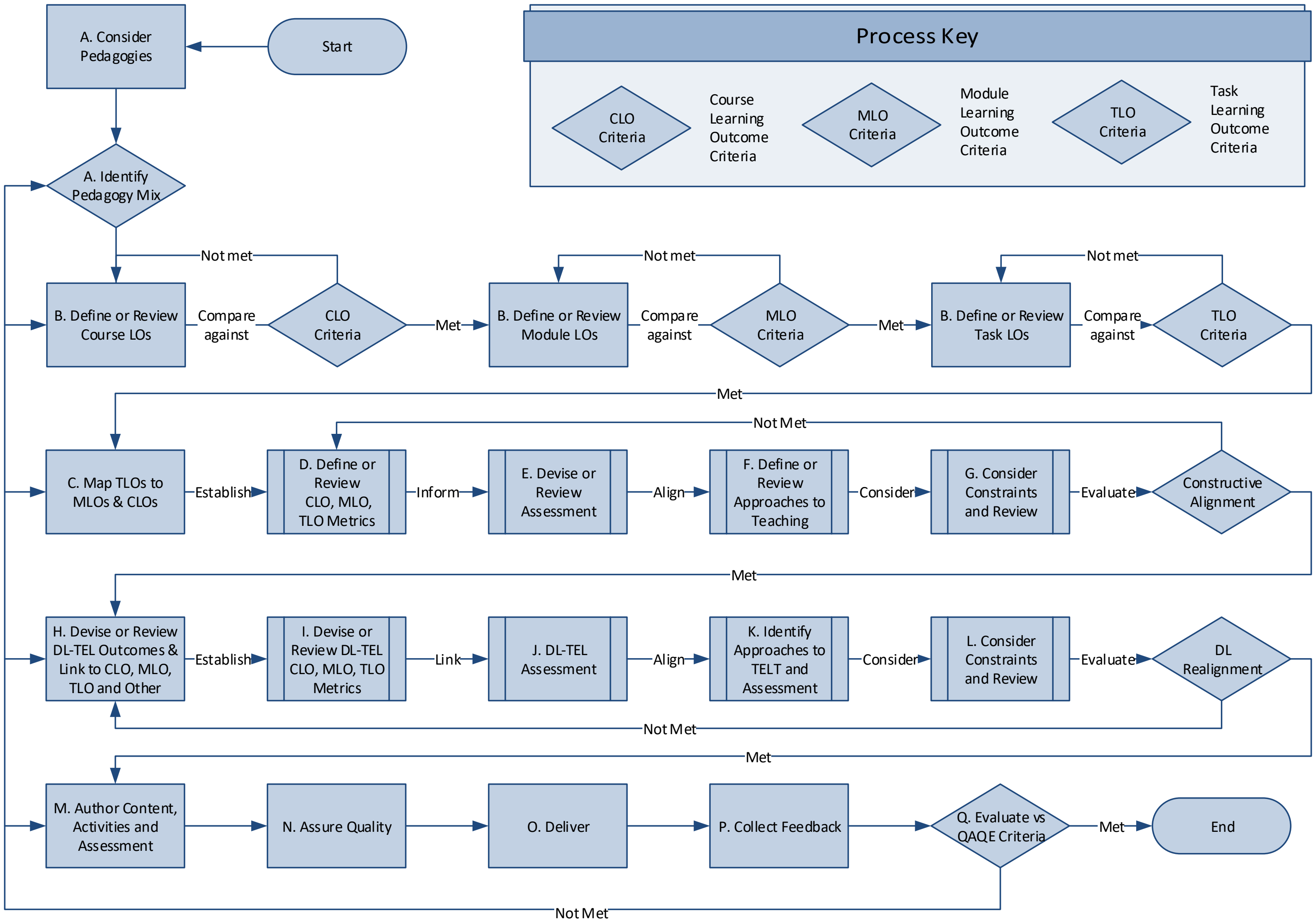


Appendix 22 - Curriculum Design Model (Model 1)

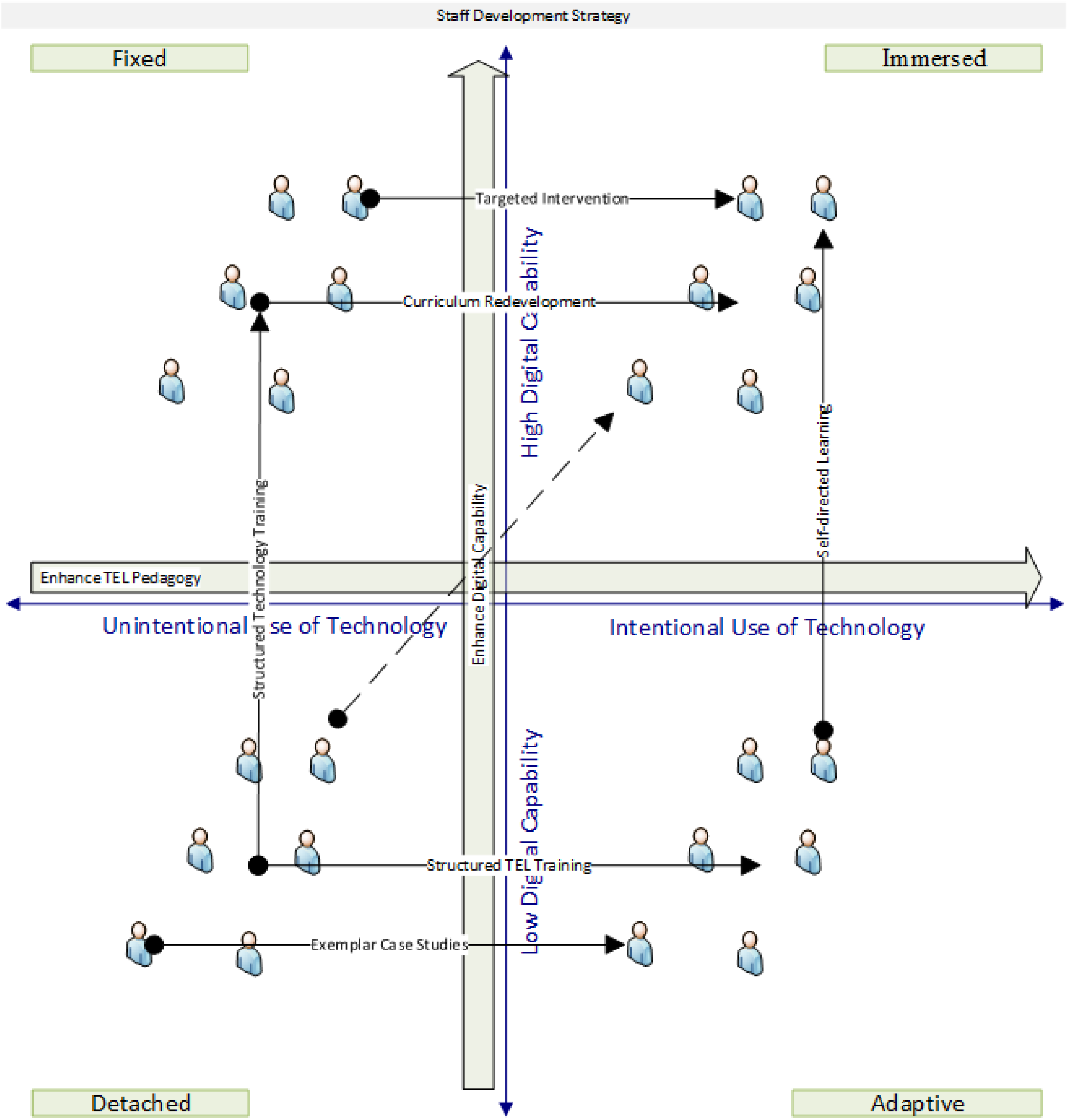



Stage II - Learning Design: Create Content, Activities, Tasks and Assessment for Learning
Learning Design Sequence
Learning Resources
Support
Design for Learning
Deliver
Task Learning Outcomes (disciplinary and co-curriculum)
Defined by
Metrics
Evaluate
Assessment for Learning
Content
Learning Activity
Learning Activity
Task Outcome (disciplinary)
Task Outcome (digital literacy)
Task Outcome (employability)
Task Outcome (disciplinary)
Task Outcome (digital literacy)
Metrics (disciplinary)
Metrics (digital literacy)
Metrics (employability)
Metrics (disciplinary)
Metrics (digital literacy)
Artefact/Evidence
Artefact/Evidence

Appendix 23 - TOOL_10 Procedural Model for Embedding Digital Literacy in the Curriculum (Model 2)



Appendix 24 - TOOL_11 Staff Development Strategy (Model 3)



Appendix 25 - TOOL_12 DL Cognitive Realignment (work in progress)

Constructive Re-alignment adapted from (Heer, 2014), (Churches, 2009) and (Krathwohl, 2002)

	Factual The basic elements a student must know to be acquainted with a discipline or solve problems in it.	**Conceptual** The interrelationships among the basic elements within a larger structure that enable them to function together.	**Procedural** How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods.	**Meta-cognitive** Knowledge of cognition in general as well as awareness and knowledge of one's own cognition.
	The Knowledge Domain			
Higher Order Thinking Skills				
Cognitive Domain - Creating Designing, constructing, planning, producing, inventing, devising, making **Digital Domain** Programming, filming, animating, blogging, video blogging, mixing, re-mixing, wiki-ing, publishing, video-casting, podcasting, directing, broadcasting	**3.1.a2 Creating simple digital content (e.g. text, or tables, or images, or audio, etc.)** - Present facts on a topic to others using simple technology to do this creatively. Example:	**3.1.a2 Producing simple digital content (e.g. text, or tables, or images, or audio, etc.)** - Present aspects of a topic or idea to others using multimedia technology to do this creatively. Example: **3.3.c1 Knowing how different types of licences apply to the information and resources you use and create** - Demonstrate an understanding on the different licences that can be applied to the material you produce and have a basic understating of the laws that relate to illegal or unethical Intellectual Property practices. Example:	**3.1.b Authoring digital assets by re-mixing content of different formats, including multimedia (e.g. text, tables, images, audio, etc.)** - Present ideas on a topic to others using presentation software, images, video and music to do this creatively. Example: **3.2.b Editing, refining and modifying content you or others have produced** - Create a report incorporating evidence from other sources (e.g. figures, tables, images, etc.) illustrating important points and ensuring that you attribute authorship appropriately. Example: **3.3.c2 Applying different types of licences to the information and resources you create** - Apply different licences to the material you use or produce and have a detailed understating of the laws that relate to illegal or unethical Intellectual Property practices. Example:	**3.1.c Programming digital content in different formats, platforms and environments by using a variety of digital tools for creating original multimedia outputs** - Create a media-rich online resource targeted to experts in your topic. Example: **3.2.c Mashing-up existing items of content to create new ones** - Produce a report using software that allows the linking of a existing datasets from sources without having to duplicate the data and critically evaluate and interpret them. Example: **3.4.c Modifying, hacking, changing or writing source code for open-source software in several programming languages** - Create software to address a real need demonstrating coding proficiency and understanding of related systems and functions that relevant to your programme. Example:

Cognitive Domain - Evaluating Checking, hypothesising, critiquing, experimenting, judging, testing, detecting, monitoring **Digital Domain** Blog commenting, reviewing, posting, moderating, collaborating, networking, refactoring, testing	**2.4.a Collaborating with others using simple technologies (e.g. email)** - Collaborate with others on a task, understand how simple technology can be used effectively to facilitate collaboration. Example: **3.2.a1 Making basic changes to content produced by others** - Edit a resource that has been produced by others to correct formatting discrepancies. Example:	**2.3.b Creating and evaluating outputs in collaboration with others using simple digital tools.** - Create a file summarising information on a topic and share it with others allowing them to make comments and add material. Example: **2.6.b Shaping an online digital identity and tracking the digital footprint** - Evaluate what you share online and analyse how this affects your e-reputation. Example: **3.2.a2 Making basic changes to content produced by others** Edit a resource that has been produced by others work to include your comments. Example: **3.3.b Knowing of the differences of copyright, copyleft and creative commons and applying some licences to your content** - Demonstrate an understanding of how copyright applies to material you use and which rights can be applied to the material your produce.	**1.2.a Evaluating the reliability of online information** - Find information from different sources about your topic, and justify their value. *Example:* **2.3.c Frequently and confidently using several digital collaboration tools and means to collaborate with others in the production and sharing of resources, knowledge and content** - Create or upload a resource on an advanced online collaboration tool which, sends notifications when resources have been edited, so that others can review and amend it. Example: **2.6.c Managing several digital identities according to the context and purpose, monitoring the information and data produced through online interaction and protecting digital reputation** - Recognise and manage the different identities that apply to learning spaces and virtual communities and participate as required to improve your learning. Example:	**1.2.c Assessing critically information and cross-checking its validity and credibility** - Produce evidence that you have looked for the sources originality and checked details across the sources to see how valid they may be. ***Example***: **4.1.c3 Regularly updating strategies for securing digital devices** - Identify weaknesses in your security plans and update according to needs. Example:
Cognitive Domain - Analysing Comparing, organising, deconstructing, attributing, outlining, finding, structuring, integrating **Digital Domain** Mashing, linking, validating, reverse engineering, cracking, media clipping	**2.6.a Awareness of the benefits and risks related to digital identity** - Analyse how people perceive personalities through what people share online. Example	**1.2.b Comparing different information sources** - Find information from different sources about a topic, and examine the originality of the material as a way to judge their value. ***Example***: **4.1.b1 Establishing a strategy for protecting digital devices** - Establish a plan for protecting digital devices. Example	**4.1.b2 Establishing and reviewing a strategy for protecting digital devices** - Establish an up-to-date plan for protecting digital devices. Example: **4.2.c Understanding of the wider privacy issues, security measures and knowledge of data collection practices** - Demonstrate an informed understanding of online privacy issues, how data is collected and used and the ability to establish comprehensive technical countermeasures. Example:	**4.1.c2 Assessing strategies for securing digital devices** - Assess the advantages and disadvantages of a variety of security plans making recommendations for their applicability. Example:

Cognitive Domain - Applying Implementing, carrying out, using, executing **Digital Domain** Running, loading, playing, operating, hacking, uploading, sharing, editing	**1.3.a Saving and Retrieving files and content (e.g. texts, pictures, music, videos, and web pages)** - Ability to create notes on a topic and save and retrieve text and images. Example: **2.1.a Interacting with others using communication tools, (e.g. mobile phone, VoIP, chat or email)** - Ability to use a chat, a discussion forum or other simple technology to communicate with others. Example: **2.2.a Sharing files and content with others through simple technological means (e.g. sending attachments to emails, uploading pictures on the internet, etc.)** - Ability to share files using simple technologies. Example: **2.3.a2 Knowing that technology can be used to interact with services and using some of them (e.g.: online communities, government, hospital or medical centres, bank, etc.)** - Ability to use online systems to interact with services such as online communities, government, hospital or medical centres or other. Example:	**1.3.b Storing, retrieving and organising files, content and information** - Ability to create notes on a topic and save and retrieve organised text and images in different file formats. *Example*: **2.1.b Interacting with others using advanced features of communication tools** - Ability to use a chat or a discussion forum to communicate with other students on my course, when necessary I can also use a group chat or VoIP and moderate it. *Example*: **2.2.b Participating in social or professional networking sites and online communities, sharing knowledge, content and information** - Use social or professional networking sites to exchange ideas and receive feedback. Example: **2.3.b Actively use features of online services (e.g.: government, hospital or medical centres, bank, eGovernment services, etc.)** - Ability and willingness to use online systems to interact with a variety of services. Example:	**1.3.c1 Applying different methods and tools to organise files, content, and information.** - Ability to create notes on a topic and manage multimedia content on a file hosting service (cloud storage). ***Example*:** **2.1.c1 Interacting with others using a wide range of tools for online communication, tailor the format and ways of communication to the audience** - Ability to use several communication tools to communicate with others (mobile phone, VoIP, chat or email). Utilise several features of VoIP like screen sharing and recording a conversation and broadcast it. ***Example***: **2.2.c Pro-actively sharing information, content and resources with others through online communities, networks and collaboration platforms** - Use online communities to share your work ensuring that contributions are appropriately recognised. **Example:** **2.3.c Pro-actively participating in several online spaces according to your needs** - Ability and willingness to use online systems to interact with a variety of services with a preference to use online/ digital modes of communication. Example:	**1.3.c2 Organising files, content, and information by deploying a set of strategies for retrieving content including that created by others** - Ability organise information on a topic by employing a set of strategies for quick and accurate retrieval. ***Example*:** **2.1.c2 Adopting digital modes and ways of communication that best fit the purpose, tailoring the format and ways of communication to the audience and managing the different types of communication you receive** - Ability to use several communication tools to communicate with others utilising several features and understand which communication tools to select, depending on the purpose and the size of the audience. ***Example***: **3.4.b Applying several modifications to software and applications (advanced settings, basic software modifications)** - Ability to customise software to suit you needs in a variety of cases/scenarios. **Example:** **4.1.c1 Pro-actively protecting devices under threat** - Ability to protect devices and systems under threat. Example:

Cognitive Domain - Understanding Interpreting, summarising, inferring, paraphrasing, classifying, comparing, explaining, exemplifying **Digital Domain** Advanced searches, Boolean searches, blog journaling, twittering, categorising, tagging, commenting, annotating, subscribing	**1.1.a2 Finding details about a specific topic or idea using an online search engine** - Ability to search for information on a topic through search engines. - Knowledge that different search engines can provide different results. ***Example***: <u>Summarise</u> features of an idea on a topic and post it on a <u>discussion board</u>. **2.3.a2 Knowing that technology can be used to interact with services and using some of them (e.g.: online communities, government, hospital or medical centres, bank, etc.)** - Knowing that online systems can be used to interact with services such as online communities, government, hospital or medical centres or other. Example: **3.3.a Appreciating that content may be restricted by copyright or other forms of intellectual property rights** - Demonstrate an understanding that certain behaviour is illegal or unethical (e.g. downloading copyrighted material without permission, plagiarising without attributing, etc.). Example:	**1.1.b2 Finding a range of sources of information about a specific topic by entering proper key words, and use a refined search strategy to locate the most appropriate sources** - Ability to articulate information needs and select the appropriate information. ***Example***: <u>Summarise</u> features of an idea and post them on a <u>discussion board</u>. **2.6.a Awareness of the benefits and risks related to digital identity** - Understand that people might have an idea of my personality through what I share online. Example: **4.1.a Protecting digital devices using simple methods (e.g. using anti-viruses, passwords, etc.)** - Understanding of how to take basic steps to protect digital devices. Example:	**1.1.c2 Utilising a wide range of search strategies when searching for information and browsing on the Internet including filtering and monitoring the information.** - Discover whom to follow in online information sharing places (e.g. micro-blogging). ***Example***: **4.2.b Protecting yourself and others privacy in online environments** - Demonstrate understanding of online privacy issues and how data is collected and used. Example:

Cognitive Domain - Remembering Recognising, listing, describing, identifying, retrieving, naming, locating, finding **Digital Domain** Bullet pointing, highlighting, bookmarking, social networking, social bookmarking, favouring/local bookmarking, searching, googling	**1.1.a1 Using a search engine to find details about a specific topic or idea** - Ability to search for information on a topic through search engines. ***Example***: List *aspects of a topic using a digital* curation tool. **3.4.a Modifying some simple function of software and applications (apply basic settings)** - Modify the style template of the word processor you are using.	**1.1.b1 Finding a range of sources of information about a specific topic by entering appropriate key words** - Browse the internet for information and find information online. ***Example***: Summarise features of an idea and post them on a discussion board. **4.2.a Knowing what types of information to share in online environments** - Recognise the types of information that are appropriate to share in online systems. Example:	**1.1.c1 Utilise a wide range of search strategies when searching for information and browsing on the Internet.** - I can find a range of sources of information about a specific form of heat energy using different search engines and advanced searches, and I can also use online databases and searches through linked references. ***Example***:
Lower Order Thinking Skills			