

1 **Evidencing the impact of coaches' learning: Changes in coaching**  
2 **knowledge and practice over time**

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## 21 **Evidencing the impact of coaches' learning: Changes in coaching** 22 **knowledge and practice over time**

23 It is clear that sport coaches learn from multiple interconnected learning experiences,  
24 yet there is limited direct evidence to elucidate what is learned and how these  
25 combined experiences shape coaches' knowledge and day-to-day practice. This  
26 research aimed to investigate the impact of the learning of two groups of English  
27 youth soccer coaches over a period of a year and a half. Using the Coach Analysis and  
28 Intervention System (CAIS) and associated video-stimulated recall interviews,  
29 changes in the practice behaviours and knowledge use of coaches completing a formal  
30 coach education course, and equivalent coaches not undertaking formal education,  
31 were compared. Data indicated that the learning period had a different effect on  
32 coaches taking part in formal coach education versus those not in education. Changes  
33 in the use of knowledge about individual players and tactics were reflected in  
34 increased behaviours directed towards individuals, and an altered proportion of  
35 technical to tactically-related questioning, linked to coaches' participation in  
36 education. Overall, more change was evident in coaching knowledge than in practice  
37 behaviours, suggesting an absence of deep learning that bridged the knowledge-  
38 practice gap.

39 Keywords: Coach learning, coaching behaviours, knowledge development, coach  
40 education, impact evaluation

## 41 **Introduction**

42 There is an ongoing concern to outline optimal frameworks for formal coach  
43 development that bring learning "under greater critical control" (Eraut, 1994, p. 62).  
44 A consequence of this is a proliferation of prescriptions *for* coach education drawing  
45 on existing literature, which consists of surveys and retrospective opinion-based

46 studies that describe and categorise the perceived development of coaches, isolating  
 47 particular learning sources or aspects of formal education programmes (e.g. Deek,  
 48 Werthner, Paquette & Culver, 2013; Sjøvik, Tjomsland, Larsen, Samdal & Wold,  
 49 2017; Stoszowski & Collins, 2015, *inter-alia*). These studies show that coaches value  
 50 learning through years of ongoing participation in practice as an athlete and coach  
 51 while also taking advantage of a variety of learning experiences ranging in formality  
 52 (Lara-Bercial & Mallett, 2016). However, categorising sources of coaches' knowledge  
 53 and exploring the use of discrete learning practices are limited as coaches learn  
 54 different things from apparently similar situations (Stodter & Cushion, 2017). Any  
 55 learning situation therefore can only be understood with reference to the blend that  
 56 constitutes the coach's wider learning and their continuously evolving biography or  
 57 network of knowledge, beliefs and attitudes (Trudel, Gilbert & Werthner, 2010). The  
 58 existing literature gives limited insight into how learning impacts coaches and  
 59 coaching, meaning there is a lack of robust empirical evidence to ascertain what  
 60 coaches gain and use from different learning experiences over time.

61         This significant gap links to the challenges of measuring, evaluating and  
 62 promoting effective learning (Griffiths, Armour & Cushion, 2016). Evaluation models  
 63 in education argue for levels of assessment above participants' reactions, to include  
 64 learning of knowledge, skills and perhaps attitudes, changes in the use of new  
 65 knowledge and skills, and outcomes of the programme (Coldwell & Simkins, 2011).  
 66 Self-report data are limited, particularly in coaching where coaches show poor self-  
 67 awareness; perceptions of practice do not correlate with observed behaviour, or with  
 68 underpinning knowledge (Millar, Oldham & Donovan, 2011; Partington & Cushion,  
 69 2013). Therefore, looking beyond self-report measures is important, and evaluation of

70 learning should focus on cognition and observable behaviour, not in isolation but  
71 interacting in practice (cf. Cushion, Ford & Williams, 2012).

72 Cognitive standpoints frame learning as “the process whereby knowledge is  
73 acquired” or “is used in a new context or in new combinations” (Eraut, 2000, p.114).  
74 One way to gauge coaches' learning is to look beyond acquisition, investigating  
75 changes in the content of knowledge and how it is used over time. Stoszkowski and  
76 Collins (2015) showed coaches desired information about pedagogy, and sport-  
77 specific knowledge, but practitioners' justification for and application of knowledge  
78 was absent, providing only retrospective perceptions of learning as knowledge  
79 acquisition.

80 The integration of knowledge, theory and practice is a key area that is difficult  
81 to develop (Nelson, Cushion & Potrac, 2012). Gilbert and Côté (2013) claim that since  
82 knowledge manifests in coaches' behaviours, naturalistic behaviour research should  
83 be integral to our understanding of coaches' learning. Behavioural observations can  
84 assess learning as behaviour change, a proxy for the knowledge coaches translate and  
85 how it is implemented (Cope, Partington & Harvey, 2017). Although behavioural  
86 observation shows ‘what coaches do’ to be a mix of instruction, positive verbalisations  
87 and periods of silence (cf. Cushion et al., 2012a), the coaching process is dynamic and  
88 subject to myriad situational, contextual and social factors. In addition, with the  
89 exception of Partington and colleagues' (2015) investigation of coaches' behaviour  
90 change, the research provides a static picture of practice limited by observations over  
91 a period of a few sessions (Cope et al., 2017). Little is known about how behaviours  
92 evolve over time, or how they alter alongside coaches' supporting reasoning,  
93 developing knowledge or learning. Single measure research designs without a baseline

94 or comparison groups overlook the temporal nature of learning (Goodall et al., 2005),  
95 therefore failing to evidence meaningful change.

96       Only a handful of small scale case-studies have used more rigorous  
97 longitudinal, multi-dimensional comparisons related to coaching practice to explore  
98 changes in knowledge or situated behaviour. Integrating participant observation, pre-  
99 and post-course interviews, systematic observation and stimulated recall, Gilbert and  
100 Trudel (1999) and Stodter and Cushion (2014) found minimal changes in coaches'  
101 practice linked to periods of formal learning. Meanwhile, interventions involving  
102 individual coaches in self-assessing their behaviours and setting associated goals have  
103 resulted in modified behaviours and heightened self-awareness (DeMarco, Mancini &  
104 Wuest, 1997; Gallo & De Marco, 2008). However, without comparison groups,  
105 separating the impact of different types of learning situation from simultaneously  
106 occurring experiences and moderating factors is problematic. The aim of this study  
107 was to address these challenges by examining the impact of coaches' learning, through  
108 the assessment of changes in the coaching knowledge and behaviours of groups of  
109 coaches undertaking, and not undertaking formal education. Coaches' use of  
110 knowledge was investigated alongside behaviours, providing another layer to inquiry  
111 over time. The significance of the research lies in providing the first longitudinal,  
112 systematic practice-linked evidence to elucidate the direct outcomes of coaches'  
113 learning experiences.

## 114 **Methodology**

### 115 ***Participants***

116 Following institutional ethics approval, eight youth soccer coaches (M age = 27.0, SD  
117 = 3.4, seven male and one female) were purposively sampled to take part (Patton,

2002). Each participant was undertaking coaching practice at least twice a week, and alongside this, five coaches were completing the same month-long sport National Governing Body (NGB) coach education programme. The three further participants not attending formal coach education acted as a non-education group, matched in terms of coaching experience, age and operating domain. Each participant was qualified to United Kingdom Coaching Certificate (UKCC) Level Two or above, with a mean of 7.9 years' experience ( $SD = 2.6$ ). Participants worked with male and female athletes of ages ranging from nine to 18. Information about the participants is shown in Table 1.

[Table 1 near here]

### ***Study Design***

This research adopted a pragmatic quasi-experimental design, based on CPD evaluation models (Coldwell & Simkins, 2011). The two groups of participants underwent multiple sessions of quantitative and qualitative data collection in baseline and follow-up phases. Immediately after the baseline phase, the 'education group' completed the NGB formal coach education course, comprising two weekends' contact time one month apart. Each weekend involved a mix of classroom-based delivery; group work; 'showcase' coaching; and simulated coaching practice with educator feedback. Course participants also completed a logbook of linked coaching sessions building towards an optional overall practical assessment. Participants were followed up six to nine months after the baseline data collection, allowing time for learning (Goodall et al., 2005). Participants were involved in data collection for a time period of one year.

142    ***Procedures***

143    *Systematic Observation*

144    In order to link coaches' learning to their behaviours within training sessions,  
 145    systematic observation was adopted. In line with previous systematic observation  
 146    studies, each participant was filmed during at least two training sessions at each time  
 147    point (Table 1), generating 2505 minutes of footage in total (Cope et al., 2017).  
 148    Observed sessions were matched in terms of the context and player groups involved,  
 149    although session content and time of season at each time point were not controlled.  
 150    An adapted version of the Coach Analysis and Intervention System (CAIS; Cushion,  
 151    Harvey, Muir & Nelson, 2012) was utilised, with six primary CAIS behaviours  
 152    identified as key behavioural markers for analysis as outlined in Table 2. Secondary  
 153    contextual-level detail (i.e. performance state, recipient, timing, content and type of  
 154    questioning) was coded for each primary behaviour, and the time spent in different  
 155    performance states was also collected and grouped into categories (Table 3). For  
 156    example, corrective feedback could have been given during a conditioned game (i.e.  
 157    playing performance state), while the athlete was completing the action (i.e.  
 158    concurrent timing), directed towards an individual (i.e. individual recipient), and  
 159    technical in nature (i.e. technical content) (Harvey, Cushion, Cope & Muir, 2013).  
 160    These behaviours and practice state categories were adopted as directly aligning with  
 161    the education course learning outcomes, a strategy previously employed to measure  
 162    programme impact (Stodter & Cushion, 2014). A trained coder coded the behavioural  
 163    and practice activity data for each category. A second trained coder carried out inter-  
 164    observer reliability, coding 10% of the data (van der Mars, 1989) and reaching 85.3%  
 165    agreement (SD = 3.4). Intra-observer agreement was 87.4% (SD = 4.8), meeting the  
 166    level of 85% to provide acceptable reliability (van der Mars, 1989).

167 [Table 2 near here]

168 [Table 3 near here]

169 *Stimulated recall interviews*

170 Qualitative data were collected using video-stimulated recall (SR) interviews to  
171 enhance behavioural observation (Cope et al., 2017) by interpreting practice  
172 behaviours, linking them to cognitive outcomes of changing knowledge. Where 'think  
173 aloud' protocols, occurring during action, may be limited by coaches' self-awareness  
174 and ability to verbalise thoughts during practice without task interference (Lyle, 2003;  
175 Whitehead, Cropley, Huntley, Miles, Quayle & Knowles, 2016), video SR interviews  
176 invite participants to recall, aided by video clips of their behaviour, their cognitive  
177 activity during that event (Lyle, 2003). SR interviews can also be tailored towards the  
178 particular research question, in this instance using interview questions linking  
179 participants' cognitions to their knowledge-in-use, reasoning, and learning. For  
180 example, participants were first invited to identify occurrences or issues arising in their  
181 coaching session that they considered relevant for discussion (Bernier, Cordon,  
182 Thienot & Fournier, 2011). They were then instructed to recall and describe the  
183 thoughts they were personally experiencing during each of these occurrences, through  
184 questions such as 'what did you notice as the session was happening?' and 'why did  
185 you intervene at this point?' After participants had described the occurrence, the  
186 researcher selected and played a corresponding video clip from pre-prepared footage  
187 of the coach's practice. At this point, participants were asked if they had anything else  
188 to add; a playback sequence designed to minimise additional layers of retrospective  
189 reflection triggered by viewing the clips (Lyle, 2003). Each of the interview clip  
190 sections was then extended with questions that linked cognitions to learning; such as



191 'what knowledge did you use' and 'where did you learn to do this?' Therefore,  
 192 although session video clips and related questions were pre-prepared by the researcher,  
 193 the interviews followed a semi-structured format based on clips chosen by each  
 194 participant and the researcher together (Bernier et al., 2011). SR interviews took place  
 195 less than a week after each observed coaching session (Gilbert & Trudel, 1999) and  
 196 lasted between 30 and 80 minutes (Table 1). Each typically covered six clips,  
 197 generating 1585 minutes of interview data overall. Research has demonstrated that  
 198 video can provide structure to reflective conversations and trigger behaviour change  
 199 in youth soccer coaches (Partington et al., 2015). As such, video SR interviews also  
 200 functioned as a 'guided reflection' intervention for all participants besides its use as a  
 201 data collection technique, enabling investigation of another informal learning source  
 202 (see section on 'Reflection').

### 203 *Analysis*

204 The systematic observation data were classified as rate per minute (RPM)  
 205 behaviours, calculated by dividing the frequency of each behaviour by the total session  
 206 time in minutes, and percentage of total session time spent in different performance  
 207 states. Data were averaged for each key marker or practice state category (Tables 4, 5  
 208 and 6) across baseline and follow-up phases of data collection, to enable assessment  
 209 of change in behavioural outcomes between time-points. The sixth primary behaviour,  
 210 general negative reinforcement occurred too infrequently to be included. The data set  
 211 consisted of discrete count data with small mean values close to zero, and practice  
 212 structure percentage data that violated the statistical assumption of independence,  
 213 which holds that one data point should not influence another (Field, 2013). Combined  
 214 with a mixed design and small sample size, inferential statistics were therefore deemed  
 215 inappropriate for these data (Ford, Yates & Williams 2010). Descriptive statistics were

216 used for percentage duration of practice states alongside primary and secondary CAIS  
 217 behaviour detail (i.e. recipient, timing, content and question type).

218 Interview data were analysed moving from basic description towards  
 219 increasingly abstract levels, using a constant comparative approach (Strauss & Corbin,  
 220 1998). Concepts relating to knowledge were produced by labelling raw data extracts  
 221 then grouping them with others sharing common characteristics and creating new  
 222 concepts when extracts did not fit (cf. Groom, Cushion & Nelson, 2011). Interview  
 223 data from the baseline phase were first analysed together, creating a matrix of  
 224 knowledge concepts that the coaches used 'pre-intervention'. Follow-up data were  
 225 then similarly coded and compared with baseline concepts in a process that involved  
 226 creating linkages, subcategories and categories connected to theoretical ideas.  
 227 Constant comparison was used to analyse changes in knowledge between the two time  
 228 points; concepts were deemed to have changed when they were qualitatively different  
 229 or mentioned more often (Saldaña, 2003). Analytical memos, peer review with a  
 230 'critical friend' and member checking of theoretical ideas were employed to enhance  
 231 rigour (Morse, 2016).

## 232 **Results and Discussion**

233 Analysis highlighted six main knowledge concepts that changed over the intervention  
 234 period, with participant groups demonstrating differing changes in knowledge use.  
 235 Systematic observation data, however, indicated that coaches' practice remained  
 236 relatively constant. Mean Rates Per Minute (RPM) of five of the primary behaviours,  
 237 alongside the secondary 'individual recipient' detail, are shown in Table 4. Each is  
 238 discussed with respect to the related qualitative themes.<sup>1</sup>

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<sup>1</sup> Interview data are labelled by participant code and 'F' for those conducted in the follow-up phase.

239 [Table 4 near here]

240 ***Technical and Tactical Focus***

241 The coach education intervention impacted coaches' *use* of tactical knowledge. Those  
242 who took part in the course initially reported using more technical than tactical  
243 knowledge in their practice, illustrated by coach E4:

244 I stepped into the whole group a couple of times to get, again, some of the  
245 basics out and then some of the technical info of running with the ball.

246 So just those technical details in different situations that you've learnt, but not  
247 only through mainstream courses, but also like your experiences of playing  
248 and also things that you see other coaches and other players do in situations.

249 This pattern was reversed on follow-up, with the same coach providing an example of  
250 his more tactically-focused thinking during practice:

251 Just knowledge really, I knew that I wanted to get them supporting the ball  
252 from different areas, the wide players and the centre, have them from the  
253 centre. The wide players were doing it already.

254 Coaches in the education group referred to the concept of tactical knowledge more  
255 often after attending the formal education course. They explained that this knowledge  
256 had come from a variety of sources, predominantly "experience of playing and  
257 coaching" (E4), but also "something that was mentioned on the [course]" (E3). E3  
258 went on to say that the way he expresses his tactical knowledge "has definitely come  
259 from" the course and the build-up of prerequisite courses. Non-education group  
260 coaches, who were seen to overall use tactics less than the education group in their  
261 questioning behaviours (Table 5), did not report the same altered tactical focus, with

262 N2 stating she was “still trying to keep the technical detail, that’s not changed really”.  
 263 Asked about their tactical knowledge, these coaches also pointed to “watching other  
 264 teams, training sessions, other coaches or games on TV...I guess that’s where it comes  
 265 from” (N1), without the additional focus of the formal coach education course. Taken  
 266 together, this evidence suggests that the education experience may have influenced a  
 267 change in coaches’ *use* of pre-existing knowledge rather than altering the *nature* of  
 268 their knowledge in this area. Coaches, consistent with other studies (e.g. Kearney,  
 269 Carson & Collins, 2018; Lara-Bercial & Mallett, 2016), were seen to draw upon a  
 270 combination of several interacting knowledge sources including playing experience,  
 271 other coaches, watching sport and formal education.

272         Significantly, changes in reported knowledge use were reflected in patterns of  
 273 coaching behaviour, specifically when looking at coaches’ use of questioning.  
 274 Secondary-level behaviour data (Table 5) showed that the proportion of technically-  
 275 based questions used by education group coaches changed differently across the  
 276 intervention period to the non-education group. There was a drop in proportion of  
 277 technical questions asked by education group coaches over time, coupled with an  
 278 increased percentage of questions about technique by non-education group coaches.  
 279 This suggests an important outcome of learning, seemingly linked to education, which  
 280 impacted on both knowledge and questioning behaviours.

281 [Table 5 near here]

## 282 ***Challenges and Questioning***

283 Questioning as a coaching intervention strategy linked to setting ‘challenges’ for  
 284 players was a central theme of the coach education course. Participants demonstrated  
 285 an altered understanding of these concepts after attending. Initial ‘lip service’ was paid

286 to implementing challenges, while in reality delivering disguised directions; “the  
 287 challenge for you is can you score from checking out and then checking in?” (E1) (cf.  
 288 Cope, Partington, Cushion & Harvey, 2016). On follow-up, coaches had adapted their  
 289 language to match an appreciation that they were attempting to allow players to make  
 290 decisions on when to perform skills, beginning to form links with the concept of  
 291 questioning:

292 “Well it’s a question isn’t it? It’s the way you word it because you know the  
 293 challenge is *can we try to...* it adds an element of choice to them that, rather  
 294 than telling them what they should be doing, there are ways, they’re achieving  
 295 something” (E2,F).

296 Knowledge of the particular language and ways of using “supporting questions to try  
 297 and draw that point out” (E1,F) was identified by coaches as an outcome of formal  
 298 learning, as “had I not been on the [course], maybe I wouldn’t have had the  
 299 knowledge” (E2,F). In contrast, coaches who did not attend the course were seen to  
 300 continue to question rhetorically without clear distinction in understanding. N1  
 301 exemplified this on consideration of his coaching intervention “that was the main  
 302 challenge initially, but it sort of became a condition”, while questioning was used in a  
 303 disconnected and rationalistic manner, “to check understanding” (N2,F).

304 Despite these reported changes in knowledge, there was no observable transfer  
 305 to coaches’ behaviour in terms of use of questions. Mean values of questioning RPM  
 306 for both groups of coaches, in Table 4 reflect a lack of change over time. Education  
 307 group coaches may have encountered a ceiling effect, given high rates ( $M = 1.27$ ) in  
 308 comparison to research with equivalent coaches ( $M = 0.69$  per minute; Cushion &  
 309 Partington, 2011), raising the issue of question content. Secondary-level coaching

behaviour data (Table 5) revealed a high ratio of convergent to divergent questions across all coaches. Convergent questions, with a limited number of responses, constrain athletes to a 'correct' answer, while effective divergent questioning requires the learner to think through problems (Cope, et al., 2016). There were no noteworthy changes in question type used by the coaches. Non-education group coaches used a higher proportion of convergent questions than education group coaches overall, a percentage split repeated post-intervention (Figure 3). This supports existing research (Cope et al., 2016) in that coaches not undertaking education adopted the general strategy of questioning, without fully understanding the type of questions asked and underpinning philosophy – in contrast to those on the course who developed linkages between knowledge concepts in this area.

### ***Practice structure***

Knowledge concepts relating to practice structure were also seen to change subtly over time. Some coaches already knew about 'whole-part-whole' design "from courses and also, I suppose college and PE" (E3). Latterly, the education group showed more detailed understanding of the concept, for instance in addressing areas for improvement through the initial 'whole' practice:

In the first game it's more about the build-up and are we getting into positions to shoot, which I think we did to a certain extent. If we hadn't done that then the part might have been slightly different. (E3,F)

These coaches attributed continued use of the whole-part-whole format directly to the formal education course, whereas non-education group coaches used the same practice structure without the equivalent level of detail around how and why. Coach N1, for example, reported implementing it second-hand because "it was the centre director's

334 direction". As a result, the structure was described in a straightforward manner, with  
 335 the 'part' seen as an opportunity to provide players with repetition of technique for  
 336 transfer into a game; implicit behaviourist assumptions that belie the approach's  
 337 intentions (Swanson & Law, 1993):

338         Yeah we did a sort of whole-part-whole approach, broke the session down,  
 339         played a big game, broke away into our teams, did some finishing, and then  
 340         played the game again. (N1,F)

341 Generally, participants showed evidence of interpretation in terms of an underlying  
 342 behaviourist theory-in-use (Argyris, 1987). Practices were designed to "build up  
 343 through warm-ups" (E5,F), starting unopposed and gradually adding in more  
 344 interference, informed by ingrained wider knowledge or assumptions:

345         "probably because a mixture of that's the way I've done things as a player,  
 346         that's the way I also do things with adults when I coach on a Saturday. The  
 347         way I've been taught as well to build things up slowly and progressively"  
 348         (E3,F)

349 The quantitative data demonstrates a lack of change in practice activities (Table 6)  
 350 which suggests an absence of meaningful learning whereby biography is 'transformed'  
 351 to accommodate new knowledge (Moon, 2001). The individual data reveals that  
 352 coaches E3 and E5 did not use any small-sided or full-sided game practices pre- and  
 353 post-intervention respectively; reflected in high standard deviations. Moreover, N3  
 354 spent 61% (S.D. = 9.9) of post-intervention practice time in playing-type activities as  
 355 he explained, "when I get big [group] numbers like that it would be a case of getting  
 356 them playing games". Practice state data was therefore heavily influenced by

individual and contextual factors, with limited evidence of impactful learning, similar to previous findings (Leduc, Culver & Wethner, 2012).

[Table 6 near here]

### ***Learning Principles***

After attending formal education, there was greater mention of giving players “situations to react to and see what works for them” (E1,F) in a more constructivist-informed approach. However, coaches would still intervene to correct mistakes or highlight positive outcomes “so they can think about what they’ve just done and attach it to a positive reinforcement” (E2,F). This reveals a behaviourist-informed interpretation of the espoused learning theory, creating a ‘naïve-constructivist’ approach (Cushion, 2013). Mean RPM values (Table 4) were consistent over the intervention period, reflecting pervasive accepted practices. RPMs of the five primary CAIS behaviours did not substantially alter between baseline and follow-up, suggesting coaches’ reliance on ‘trademark’ behavioural profiles that were relatively resistant to change over time. The concept of constructivist-informed learning principles was therefore assimilated into coaches’ existing repertoires on the basis of assumed similarity to their existing practice, without cognitive changes (Leduc et al., 2012).

### ***Players***

Coaches’ use of interpersonal knowledge relating to players appeared to alter, with participants in the education group reporting using concepts of individuals’ learning, abilities and personalities to a greater extent. Coach E1 exemplifies his use of these three concepts in combination:



380 I know Josh now and he needs to be challenged and this didn't really challenge  
 381 enough in this set up so he just kind of strolled through it. But then when it  
 382 comes to the game he brings that mentality with him a bit...No he's a good  
 383 player, he should do it...Some of them will try to do it because they're into  
 384 that learning and they've got the idea that they're going to learn something by  
 385 trying it. But Josh doesn't seem to have that. (E1,F)

386 Following on from this, systematic observation data were examined for behaviours  
 387 directed towards individuals (see table 4). Mean values showed a trend whereby on  
 388 average, coaches increased their rate of coaching behaviours directed towards  
 389 individuals after attending formal education, with behaviours in the non-education  
 390 group showing no change. Data indicated that this was mainly due to large changes in  
 391 individually-directed behaviours by coaches E1 and E4, who displayed increases of  
 392 77% and 98% respectively. With a high baseline RPM of 2.18, coach E4  
 393 acknowledged that 'speaking to individuals is kind of what we've done a lot of anyway  
 394 before the course', yet this behaviour had almost doubled in frequency on follow-up,  
 395 apparently linked to setting and exploring individual challenges; 'just from experience  
 396 that since I've started doing that in the sessions, it's been kind of effective' (E4,F). By  
 397 comparison, E2 increased RPM behaviours towards individual recipients by 11% and  
 398 E5 by 17%, while E3 showed a 15% decrease. These findings are valuable in  
 399 suggesting learning bridging the knowledge-practice gap, in particular when  
 400 reinforcing previous practices. Coaches appeared to develop a greater focus on  
 401 individuals "from the [course], that I've learnt to maybe think about the players in a  
 402 group more, rather than just actually what the session is" (E2,F).

403 ***Reflection***

404 Finally, coaches not taking part in formal education demonstrated changes in their use  
405 of intrapersonal knowledge concepts, relying on “a little reflection in action, and  
406 reflection on action afterwards” (N1) “to generate new knowledge” (N3). Coach N2  
407 explained,

408 I’m starting to think a bit more...to get to know the players, to get to know  
409 what I’m dealing with...I’ve started to look for different things from when I  
410 did the first lot [of interviews]. (N2,F)

411 The data suggests this enhanced use of reflection was linked to taking part in the SR  
412 interview protocol. It is unclear why only the non-education group reported changing  
413 use of reflective practice however. Interview data aligned with evidence that  
414 individuals’ pre-existing knowledge, coupled with coaching contexts, influenced this  
415 learning. For example, coach N3 described how “I’m always kind of reflecting”, as  
416 “one thing I did learn at university was the value of the reflection cycle”. As a result,  
417 he was able to engage in reflective conversations facilitated by club context, informing  
418 practice: “that [behaviour] was just a gradual thing that we developed through the club  
419 and just as coaches talking and discussing and reflecting really”. It may be that SR  
420 interviews provided a particular contextual impetus and a framework for coaches not  
421 taking part in formal education to develop reflection (Gilbert & Trudel, 2001).

## 422 *Study Limitations*

423 Although the sample size employed was larger than in previous studies, descriptive  
424 statistics were most appropriate for analysing groups of coach behaviours, limiting  
425 widely generalisable conclusions. Indeed, the complex and situation-specific nature of  
426 coaching is a confounding factor that impacted on the level of variability in behaviour.

427 While maintaining a naturalistic approach is important, future research could aim to  
428 recruit larger groups of coaches working within the same context, account for factors  
429 such as session content and timing within athletic seasons, and observe more coaching  
430 sessions over longer time periods (Cope et al., 2017), enabling inferential statistics to  
431 add weight to the claims made.

## 432 **Conclusion**

433 The results of this study demonstrate that learning had an impact on coaches'  
434 knowledge and practice behaviours. Completion of a formal education course  
435 influenced changes in the use of knowledge around tactics and engaging with  
436 individual players, reflected in an altered proportion of technical to tactically-related  
437 questions and a trend towards increased behaviours directed at individuals.  
438 Participants also showed evidence of changes in knowledge of practice structure,  
439 challenges and questioning, learning principles and reflection, although behaviours  
440 and practice activities generally remained consistent in these areas. The minimal  
441 impact of learning on observed coaching behaviour, alongside interview data, revealed  
442 some disconnect between knowledge and situated action, suggesting a lack of deep  
443 learning (Moon, 2004) around the theoretical underpinnings of certain practices.  
444 Coaches were able to adopt and reinforce knowledge without challenging deeply held  
445 assumptions, reflecting common criticisms of coach education as a relatively 'low  
446 impact' endeavour for generating meaningful change. 'Traditional', 'deep seated'  
447 practices can be resistant to change, and changing behaviour is particularly  
448 challenging using short, formal coach education courses. While some impact was  
449 evidenced here, the findings pose questions to the duration and follow-up of  
450 educational episodes. It was apparent that coaches not taking part in formal education

451 developed across a narrower range of concepts over the same period. While learning  
 452 was linked to a variety of interacting sources including coaching and playing  
 453 experiences, the evidence suggests formal education did have added 'learning impact'  
 454 for those taking part.

455         The results highlight the importance of exploiting mixed methods to enable  
 456 longitudinal monitoring of coaches' thinking and behaviours and examine how  
 457 cognitive changes are reflected in contextualised practice. Unlike the prevalent self-  
 458 report perceptions of learning, a more integrated approach can illuminate the unseen  
 459 reasoning behind coaches' behaviours and provide an index of change. This research  
 460 is the first to provide direct evidence of the impact of learning experiences in multiple  
 461 coaches over time. Learning from education was demonstrated to interact with  
 462 previous knowledge and individual and contextual factors (e.g. Stodter & Cushion,  
 463 2017). Therefore research that takes a view of coaches' wider learning as an integrated  
 464 whole is needed to better understand coaches' development.

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Table 1. Participants, design and data collection for each participant group. Key: E = Education group, N = non-education group, SR = Stimulated Recall

Participant number	Coaching Context	Age	Years Coaching	Baseline Data Collection				Follow-up Data Collection			
				Observation M Minutes	S.D.	SR Interview M Minutes	S.D.	Observation M Minutes	S.D.	SR Interview M Minutes	S.D.
E1	Centre of Excellence / Further Education College Academy	27.9	10.8	162.4	11.5	99.8	69.9	135.4	46.1	89.6	44.5
E2		26.9	5.5								
E3	Centre of Excellence	35.3	9.8								
E4	Centre of Excellence	24.0	7.0								
E5	Centre of Excellence	26.5	3.8								
N1	Girls' Player Development Centre / Further Education College Community	23.7	8.0	172	11.3	110.3	41.3	166.7	18.9	102.3	34.9
N2		27.1	12.0								
N3	Academy	24.8	6.0								

Table 2. Primary behavioural observation classifications and descriptions in the CAIS coding process (Adapted from Cushion et al., 2012)

<b>Behavioural Classification</b>	<b>Behavioural Description</b>
Specific Feedback (positive)	Specific positive verbal statements that specifically aim to provide information about the quality of performance, e.g. 'that was good defending'
Specific Feedback (negative)	Specific Feedback (negative) Specific negative verbal statements that specifically aim to provide information about the quality of performance e.g. 'don't force the pass'
General Feedback (positive)	General positive verbal statements or non-verbal gestures, e.g. 'good'
General Feedback (negative)	General negative verbal statements or non-verbal gestures, e.g. 'don't do that again'
Corrective Feedback	Statements that contain information that specifically aim to improve the player(s) performance at the next skill attempt e.g. 'pass it earlier next time'
Question	Coach asks a question

Table 3. Categories of practice states, adapted from the CAIS (Cushion et al., 2012).

<b>Practice State Category</b>	<b>Performance State Classification</b>	<b>Definition</b>
Game state	Small sided game Full sided game	Two goals, realistic to regulation rules, both teams scoring in the same way
Playing state	Phase of play Possession game Conditioned game	Attack vs. defence play which differs from a game state in adaptations to rules, e.g. only one team scores, variations in goals, scoring or area of play
Practice/Training state	Physiological Technical practice Skills practice Functional practice	Warm-up or cool down Individual/group activity covering isolated technical skills or game incidents and patterns; unopposed or opposed
Transition/Management state	Other	Coach is managing/addressing players to explain practices or transition to new practice state; breaks

Table 4. Table showing mean values for Rate Per Minute of coaching behaviours at baseline and follow-up for education and non-education groups.

<b>Behaviour (Mean Rate Per Minute)</b>	<b>Participant Group</b>	<b>Baseline</b>		<b>Follow up</b>	
		<b>M</b>	<b>S.D.</b>	<b>M</b>	<b>S.D.</b>
Questioning	Education	1.27	0.59	1.28	0.40
	Non-Education	0.65	0.18	0.93	0.16
	Total	1.04	0.56	1.15	0.36
General Reinforcement (+)	Education	0.92	0.48	1.05	0.63
	Non-Education	1.18	0.48	0.89	0.28
	Total	1.02	0.47	0.99	0.51
Specific Reinforcement (+)	Education	0.39	0.07	0.53	0.16
	Non-Education	0.42	0.09	0.55	0.20
	Total	0.40	0.05	0.54	0.13
Specific Reinforcement (-)	Education	0.10	0.11	0.18	0.18
	Non-Education	0.24	0.33	0.44	0.62
	Total	0.15	0.21	0.28	0.38
Corrective Reinforcement	Education	0.26	0.18	0.44	0.30
	Non-Education	0.20	0.14	0.18	0.14
	Total	0.23	0.16	0.35	0.27
Individual Recipient	Education	1.71	0.41	2.37	1.14
	Non-Education	1.87	1.15	1.86	0.44
	Total	1.77	0.69	2.18	0.93

Table 5. Table showing mean values for percentage of secondary questioning behaviours at baseline and follow-up for education and non-education groups.

<b>Behaviour (%)</b>	<b>Participant Group</b>	<b>Baseline</b>		<b>Follow up</b>	
		<b>M</b>	<b>S.D.</b>	<b>M</b>	<b>S.D.</b>
Technical Question (%)	Education	25.46	10.20	10.31	8.03
	Non-Education	14.57	5.17	24.39	4.27
	Total	21.37	9.93	15.58	9.75
Tactical Question (%)	Education	54.73	10.19	62.46	21.83
	Non-Education	32.74	12.16	21.31	13.88
	Total	46.49	15.20	47.03	27.95
Divergent Question (%)	Education	19.87	5.33	20.33	6.64
	Non-Education	13.03	7.51	10.41	0.32
	Total	17.30	6.70	16.61	7.18
Convergent Question (%)	Education	80.00	5.37	79.39	6.06
	Non-Education	86.38	8.49	88.78	0.83
	Total	82.39	6.93	82.91	6.69

Table 6. Table showing mean values for percentage time spent in different practice states at baseline and follow-up for education and non-education groups.

<b>Practice State (% Time)</b>	<b>Participant Group</b>	<b>Baseline</b>		<b>Follow up</b>	
		<b>M</b>	<b>S.D.</b>	<b>M</b>	<b>S.D.</b>
Game	Education	18.08	15.28	15.96	14.00
	Non-Education	21.20	7.84	21.47	3.10
	Total	19.25	12.39	18.03	11.09
Playing	Education	25.80	6.77	24.60	11.84
	Non-Education	22.60	8.73	32.13	15.29
	Total	24.20	5.52	28.37	9.67
Training	Education	34.34	7.79	38.12	10.40
	Non-Education	32.10	10.05	20.60	13.42
	Total	33.22	6.38	29.36	8.49
Other	Education	21.75	2.97	20.69	2.09
	Non-Education	24.13	3.83	25.95	2.69
	Total	22.94	2.43	23.32	1.70