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 Bridging the Gap Between Science and Application: The Use of Cocreation Educational Workshops in Professional Youth Soccer

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Article

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1   ORIGINAL RESEARCH

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3   **Bridging the gap between science and application: The use of co-creation to modulate practice**

4   **activities employed by professional youth soccer coaches through feedback and workshops**

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8

9   **Abstract**

10   We examined whether practice activities adopted by professional youth soccer coaches are

11   modulated through the implementation and engagement with co-creative evidence-based programmes.

12   Across two experiments, we used systematic observation to identify the practice activities of 7 coaches

13   across 134 sessions. In Experiment A, drill-based and games-based activities were recorded and

14   quantified. To encourage behaviour change across the study, the systematic observation data were

15   compared to skill acquisition literature to provide coaches with quantitative feedback and

16   recommendations during workshops. Post-workshop systematic observation data indicated that practice

17   activities used by coaches changed in accordance with the evidenced-based information (increase in

18   games-based activities) delivered within the workshop. Interview data indicated that coaches typically

19   stated the workshop was a key reason for behaviour change. In a follow-up Experiment B, feedback

20   and recommendations were delivered using an interactive video-based workshop. The systematic

21   observation data indicated that coaches increased the use of soccer activities that contained active

22   decision-making, with coaches citing the workshop as a key reason for behaviour change. These

23   findings indicate that coaching practice activities can be supported and shaped through the

24   implementation of co-created workshops where coaches collaborate with sport scientists and

25   researchers to bridge the gap between science and application.

26

27   **Key Words:** Soccer coaching; Skill acquisition; Education programme and workshop

28　　**Introduction**

29　　　　Although there were over 1.25 million coaches working in the United Kingdom in 2011, two

30　　thirds of all coaches reported that they have never undergone continuing professional development

31　　(CPD). As a result, sports organisations, governing bodies, and other educational organisations have

32　　made the education of coaches a priority (SportsCoachUK, 2011). A main role for a coach is to plan,

33　　deliver and evaluate coaching sessions, with the knowledge underlying these processes often acquired

34　　from emulation and experience, rather than being based on scientific theory and research findings

35　　(Williams & Hodges, 2005). A suggestion posed to close the gap between coaching and science is for

36　　coaches, coach educators and applied researchers to 'co-create' education progrmames (Cushion, Ford,

37　　& Williams, 2012; Partington & Cushion, 2013).

38　　　　Soccer players spend large amounts of time in coach-led practice activities with the aim of

39　　obtaining the necessary motor and perceptual-cognitive skills required for developing expert

40　　performance needed to meet the demands of the professional game (Williams & Reilly, 2000; Ford et

41　　al., 2012; 2020). The practice activities employed by coaches are subdivided into two main categories:

42　　drill-based, and games-based, activities (Ford, Yates, & Williams, 2010). Drill-based activities involve

43　　the repetition of isolated skills involving limited or no opposition, such as fitness activities, technique

44　　and skill practice (O'Connor, Larkin, & Williams, 2018). When using drill-based activities, the coach

45　　typically pre-determines and plans the outline of the decision(s) for players. This means players are

46　　unlikely to have many opportunities to develop these skills alongside related games-based processes

47　　such as active decision-making associated with selective-attention and visual search. Games-based

48　　coaching activities involve opposition and teammates that closely replicate the demands of the game,

49　　such as small-sided games, phases of play, conditioned and possession games (Partington & Cushion,

50　　2013; O'Connor, Larkin, & Williams, 2017; O'Connor et al., 2018). These dynamic soccer-specific

51　　environments provide a much greater opportunity for players to acquire processes that support the

52　　development of planning, selection and execution of appropriate goal-directed actions. Players are

53　　therefore constrained to make self-selected active decisions based on the interaction between their own

54　　experience, positioning of teammates, opposition, and space. Although games-based activities offer

55　　benefits for developing these processes, coaches typically opt to make the game easier for young novice

56   players by reducing the attentional demands (i.e., decision-making) through the use of drill-based

57   activities (e.g., grid-based passing; turning; ball control). Once coaches determine that these skills have

58   been acquired to an acceptable level, the sessions are progressed (i.e., using a 'scaffolding' coaching

59   methodology, see Jones & Thomas, 2015; or at the 'challenge-point', see Guadagnoli & Lee, 2004) by

60   introducing more opportunities that encourage coaches/players to be actively involved in the learning

61   process (Jones & Thomas, 2015), and/or by specifically moving session designs toward a games-based

62   approach (Ford et al., 2010) in order to encourage and constrain the acquisition of more advanced

63   (expert-like) soccer specific active decision-making skills.

64   Expert performance in soccer match-play requires an interaction of motor and perceptual-

65   cognitive skills (Fowler & Turvey, 1978; Hanford et al., 1997; Williams & Ford, 2013). These

66   perceptual-cognitive skills include: *visual search*, which is scanning of the visual environment to

67   evaluate space, the ball, and the movements of opponents and teammates; *anticipation*, which is the

68   ability of a performer to predict what events and/or actions are likely to unfold prior to an event

69   occurring; and *decision-making,* which is the ability to use information from the current situation to

70   plan, select and execute an appropriate goal-directed action (Ford & Williams, 2013). The interaction

71   between motor and perceptual-cognitive skills observed during match-play is very difficult to replicate

72   using drill-based activities. Still, it is suggested (Ford et al., 2010) that coaches should attempt to

73   simulate this interaction in practice drills such that players are provided with the opportunity to develop

74   the motor and perceptual-cognitive skills needed to perform during match-play. Games-based activities

75   go some-way to containing the key elements of match-play. For example, Miller et al. (2016) observed

76   a significant increase in decision-making ability by junior netball players during small-sided games

77   following an increase in games-based activities employed in their practice sessions.

78   Games-based activities may require random (i.e., attempts at multiple skills occur in a random

79   order such that one skill is usually followed by attempts at another) and variable (i.e., each attempt

80   contains different factors of the same skill, e.g., distance; speed) skill attempts throughout the coaching

81   session. From a skill acquisition perspective, it has been shown that random/variable practice facilitates

82   the development of generalised skill acquisition compared to constant/blocked/serial practice for both

83   motor and perceptual-cognitive skills (Lee & Magill, 1983; Shea & Kohl, 1991; Li & Wright, 2000).

84   For instance, Broadbent et al. (2015) examined perceptual-cognitive skills in tennis using a laboratory-

85   based task. During practice, skills (forehand groundstroke; forehand smash; forehand volley) were

86   presented in a blocked or random practice order. In a field-based (i.e., similar to match-play) retention

87   test, those who practised in a random/variable order showed superior learning (response accuracy)

88   compared to those who practised in a blocked/serial order. Games-based activities promoted task

89   switching that modulated an increase in cognitive effort, and error detection processing, that developed

90   the underlying processes that facilitated retention and transfer. Therefore, more time in spent in games-

91   based activities may be an effective strategy to be incorporated into coaching sessions when the goal is

92   to develop soccer-specific motor and perceptual-cognitive skills (Williams & Hodges, 2005; Ford et

93   al., 2010; Low et al., 2013).

94   Despite games-based activities facilitating greater acquisition of soccer-specific processes,

95   coaches typically spend more time utilising drill-based, compared to games-based, activities (Ford et

96   al., 2010; Partington & Cushion, 2013; Low et al., 2013; Partington, Cushion, & Harvey, 2014; Hall,

97   Gray & Sproule, 2016; Cope, Partington, & Harvey, 2017). For instance, Ford et al. (2010) used

98   systematic observation to film and analyse 70 practice sessions of soccer coaches in the UK at three

99   different age groups (U9s; U13s; U16s), and three different player ability levels (academy; centre-of-

100   excellence; amateur). The data showed that irrespective of age or player ability coaches had soccer

101   players spend an average of 65% of time in drill-based, compared to 35% in games-based, activities

102   (see also Partington & Cushion, 2013; Partington et al., 2014). The relatively high amount of time spent

103   in drill-based activities is somewhat different to data from motor learning research (Williams & Hodges,

104   2005; Ford et al., 2010), which indicates that more effective transfer of motor and perceptual-cognitive

105   skill acquisition comes from practice environments that contain elements of variability of practice and

106   contextual interference (i.e., games-based activities). A possible explanation for a 'science-application'

107   gap is that most soccer-coaching knowledge is acquired through coaching experience, emulation of

108   other coaches (e.g., head coach), and via informal activities (e.g., websites; blogs; books). This process

109   can result in the development of craft knowledge that is typically based on established and traditional

110   coaching approaches (Cushion, Armour, & Jones, 2003; Williams & Hodges, 2005; Cassidy & Rossi

111   2006; Gilbert et al., 2009; Young et al., 2009; Cushion et al., 2012; Partington & Cushion, 2013), rather

112   than on scientific evidence delivered via formal professional coach education (e.g., courses, workshops,

113   CPD) programmes (Gilbert, Côté, & Mallett, 2006; Stoszkowski & Collins, 2016).

114   To bridge the gap between science and application, coaches, players and applied researchers

115   could 'co-create' coach education programmes (Cushion et al., 2012; Low et al., 2013; Partington &

116   Cushion, 2013) via a process of continuing professional development (CPD). A co-creation CPD

117   process that actively includes the learner (i.e., a coach; see Nelson, Cushion, & Potrac, 2013) may be

118   an effective learning environment that takes into account the complexity of many interacting factors

119   that constrain the social-sporting world (Jones, Armour, & Potrac, 2002; Jones et al., 2010). Whilst it

120   has often been assumed that coaching is 'clean and sequential' (Cassidy, Potrac, & Jones, 2008), and

121   underpinned by technical, tactical and some forms of bio-scientific data (e.g., GPS; heart rate; blood

122   lactate), it is suggested (Potrac & Jones, 2009) that coaches can be quite persuasive in terms of

123   embedding their own coaching philosophy/agenda. Although professional coaches express ideas that

124   are consistent with some findings from the skill acquisition literature, including processes related to

125   perception-action coupling, and structure of practice (Greenwood, Davids, & Renshaw, 2012), a fitting

126   environment might be to have coaches (e.g., Purdy, Jones, & Cassidy, 2009) collaborate with other key

127   stakeholders (e.g., academy director; scientists) in order to co-design coaching methodologies

128   (Greenwood et al., 2012; Nelson et al., 2013) based on assimilating evidence from experiential

129   knowledge and research findings. In this context, coaches may be more motivated to modify and adapt

130   their philosophy and repertoire such that practice activities also contain evidenced-based (i.e., scientific

131   evidence) information on motor and perceptual-cognitive skills (Williams & Hodges, 2005).

132   To this end, we designed and conducted a 2-experiment study to investigate the effectiveness

133   of CPD educational workshops on supporting coaches to modify the nature of the practice activities

134   used in a youth UK soccer academy. The aim of Experiment A was to investigate whether coaching

135   behaviour could be supported to implement more 'gamed-based' activities during youth coaching

136   sessions. As illustrated in **Figure 1** (top panel), coaches were offered the opportunity to engage in an

137   eight-phase experimental protocol. First, we (lead author, SH) engaged in meetings with the Head of

138   Sport Science and Medicine (HSSM), and the Academy Director (AD) of the professional football club,

139   in order to co-create the educational basis of the workshop. Second, we measured practice activities

140   (pre-workshop) using systematic observation (Ford et al., 2010). Third, we conducted interviews

141   (Interview A1) in order to gain an understanding of why coaches employed certain practice activities

142   when delivering coaching sessions. Fourth, we then delivered the CPD education workshop based on

143   the data from the systematic observations (SOA1), and evidence from the scientific literature on motor

144   learning, skill acquisition and expert performance (Ford & Williams, 2013). Fifth and sixth, following

145   the workshop, a second block of systematic observations (SOA2), and interviews (Interview A2), were

146   carried out (post-workshop). Seventh and eighth, to establish if and why coaches continued to use

147   modified practice activities after the post-workshop, a third block of delayed systematic observations

148   (SOA3), and interview (Interview A3), were carried out after a 3-month period of no soccer coaching

149   activity. It was predicted that across experimental phases, a significant increase in time using gamed-

150   based activities would be adopted by coaches following the workshop.

151

152   Experiment A

153   *Participants*

154   Volunteers were professional youth soccer coaches (n = 7) from an English Football

155   Association Youth Academy. The coaches worked with players from 6 to 12 years of age. The coaches

156   mean age was 39.64 ± 8.22 years and their average coaching experience was 13.96 ± 10.80 years. All

157   coaches possessed Union of European Football Associations (UEFA) coaching licenses by 'The

158   Football Association' (The FA). One participant possessed the UEFA 'A' coaching license (Level 4/5

159   in the coaching qualification pyramid), two participants possessed the UEFA 'B' coaching license

160   (Level 3/5) and the remaining four possessed the UEFA 'C' coaching license (Level 2/5). Four out of

161   the seven coaches had also undertaken the FA Youth Award Modules Level 1, 2 and 3. All participants

162   provided written informed consent and were free to withdraw at any time. The study was designed in

163   accordance with the Declaration of Helsinki and was approved by the host University ethics committee.

164

165   *Co-creation process*

166   To co-create the CPD education workshop, the lead researcher had four meetings with the

167   HSSM and AD (see top panel of **Figure 1**). These meetings were initiated by the club through existing

168   communication channels associated with already established working relationships with other research

169   disciplines (i.e., strength and conditioning; physiology). The meetings took place in various facilities

170   within the club (e.g., indoor training centre), and were initially informal in the developmental stage of

171   the working relationship. These meetings included:

172   (1) The initial meeting between the lead researcher and HSSM was focused on exploring the

173   prospect of conducting evidence-based research within the club. The HSSM initiated the contact by

174   indicating a desire to develop a working relationship with external applied skill acquisition specialists

175   in order to promote and employ the use of evidence-based coaching practices. To facilitate discussion,

176   a number of coaching sessions were observed across different age groups in order to get a context of

177   the types of practice activities being used at the club. The discussion centred on the types of practice

178   activities, terminology used in the club, the philosophy of coaching practice, and the goals of the

179   academy.

180   (2) Once a working relationship was established between the lead researcher and HSSM, a

181   second meeting was organised with the AD in order to discuss the operational aspects of the academy,

182   the overarching coaching philosophy within the academy, and the fundamental principle of developing

183   a collaborative long-term working relationship working with the club. The lead researcher outlined the

184   scientific expertise of the research team in the areas of systematic observation, motor behaviour, skill

185   acquisition, and coaching. Plus, to confirm that the research team was very motivated to work with the

186   professional club in a collaborative relationship to co-create CPD education workshops. At the meeting,

187   discussions were centred on the types of practice structures used by the coaches (based on the

188   observation made in meeting 1), and how these activities relate to the motor and perceptual-cognitive

189   mechanisms/processes available from motor learning/skill acquisition literature, and the overarching

190   requirements of The Premier League's Elite Player Performance Plan (EPPP). Through these

191   conversations, the needs and philosophy of the club were outlined and explored in relation to

192   collaborative research projects and following these discussions an agreement was made to develop a

193   working and trusting relationship.

194   (3) In the third meeting, the lead researcher, HSSM and AD observed further coaching sessions

195   followed by discussions on the principles of drill-based and games-based activities, together with

196   concept of the CPD education workshop and feedback to the coaches. The lead researcher provided

197   examples of evidence-based soccer practice activities to the HSSM and AD in order to outline the

198   benefits of implementing certain sessions (e.g., Harvey, Cushion, & Massa-Gonzalez, 2010; Ford &

199   Whelan, 2016). Given that the AD was principally responsible for the coaches and CPD, further

200   discussions were had in order to explore important issues to do with ethics around CPD educational

201   workshops, and the involvement of the coaching staff. Issues related to data collection, analysis and

202   storage, and importantly that the coaches had the right to consent to volunteer, or not. Following this,

203   the AD and HSSM had independent discussions with the coaches to determine how and if the club

204   wanted to implement the potential study. It was decided that a co-creative approach was the most

205   desirable method to link the club, coaches, and research team.

206   (4) The fourth meeting set about the process of co-creating the CPD education workshop, as

207   well as the working parameters for the parties. Logistics were discussed surrounding the systematic

208   observation (i.e., coaches, dates, and times). The lead researcher and AD discussed the dialogue type to

209   be used in during the CPD education workshop, as well as the most effective method by which to present

210   the data to the coaches (Nosek et al., 2021) with quantitative feedback from the systematic observation

211   data. It was agreed that a small A5 laminated infographic based technical-report would be produced to

212   convey the quantitative information associated with coach behaviour (i.e., %Time spent in games-based

213   activities) as this would be an effective medium to further promote discussions between the research

214   team and the coaches during the CPD education workshop (Martin et al., 2019).

215

216   ***Coach education workshop***

217   As illustrated in **Figure 1**, a standard CPD educational workshop was delivered to coaches in

218   small groups and consisted of two main parts. First, feedback was provided to each coach in the form

219   of an A5 laminated infographic that contained definitions of drill-based and games-based activities, as

220   well as a description of how these activities impacted skill acquisition in soccer (Ford & Williams,

221   2013). The infographic also included the practice activity data recorded from the systematic

222   observations (SOA1) (upper panel **Figure 1**), which was illustrated in pie charts alongside descriptive

223   (percentage data) statistics. Drill-based and games-based activity data from Ford et al. (2010) was also

224   provided to allow a comparison to English Premier League clubs. Finally, the infographic provided

225   feedback for how coaches could increase the amount of games-based activities. Second, the coaches

226   engaged in a CPD education workshop led by the lead researcher, HSSM and AD. The coaches were

227   divided into two groups who each attended one of two workshops. The first workshop contained U7s -

228   U10s team coaches, and the second workshop U11s - U13s team coaches. The workshops lasted for

229   approximately 60 minutes. In the workshop, definitions of drill-based and games-based activities were

230   reiterated and discussed, and where necessary contextualised with soccer examples, and coaches were

231   offered an opportunity to seek clarification and comment. The coaches were asked to be an active

232   member of the process by interpreting the mean percentage drill-based and games-based activity data

233   from the technical infographic. For comparison purposes, and in order to promote discussion about their

234   own findings, the coaches were asked to consider the results from SOA1 to the data reported by Ford

235   et al. (2010), which showed that Premier League academy coaches spent $60 \pm 20\%$ in drill-based, and

236    $40 \pm 20\%$ in games-based, activities. To promote a rationale for increasing games-based activities, the

237   workshop was designed to outline the scientific principles underpinning the benefits of developing

238   motor and perceptual-cognitive skills through the use of more games-based activities such as random

239   and variable skill attempts (Ford et al., 2010; Ford & Williams, 2013). Coaches were again encouraged

240   to be active in the process by discussing the principles of drill-based, and games-based, activities (i.e.,

241   peer-to-peer learning; and coach-to-researcher learning) in order to establish how and why they could

242   modify their own practice activities to contain more games-based processes. The examples created and

243   forwarded by the coaches were then discussed with the lead researcher in order to assimilate the new

244   coaching session designs with the scientific principles of games-based practice. Finally, all coaches,

245   and the academy staff (AD and HSSM), agreed to the merits of games-based practice and collectively

246   committed to implementing the new principles in follow-up coaching sessions.

247

248   ***Systematic observation***

249   Systematic observation is a technique adopted by researchers/practitioners to analyse coaching

250   practices (Ford et al., 2010; Low et al., 2013; Partington & Cushion, 2013). It allows an analyst to

251   observe, record and analyse observable behaviours and events based upon based on pre-set guidelines

252   and criteria (Franks, Hodges, & Moore, 2001; Partington & Cushion, 2013). Based on the work by Ford

253   and colleagues (Ford et al., 2010; Low et al., 2013), three soccer practice activity categories were

254   identified for analysis: drill-based, games-based, and transition (see **Table 1**). Drill-based was defined

255   as 'activities performed in small groups or isolation that did not have a game play context, such as

256   opponents or teammates'. It included fitness activity without a ball (warm-up; conditioning; cool-

257   down), technique practice, and skills practice. Games-based was defined as 'activities that had a game

258   play context, with opponents and teammates'. It included phase of play, conditioned small-sided games,

259   small-sided games, and possession games. Transition was defined as 'when players moved between

260   activities or engaging in activities with no soccer or fitness focus'. The systematic observation

261   instrument used was designed in accordance with Brewer and Jones (2002) and has been used in our

262   previous work (Ford et al., 2010). This five-stage procedure for establishing the instrument was: (1)

263   observer training: the two coders had experience of systematic observation and the definitions of the

264   practice activity categories; (2) instrument modification to ensure content validity; (3) establishing face

265   validity: both of which have already been tested in our previous work (Ford et al., 2010); (4) establishing

266   inter-observer reliability: to obtain reliability with the categories and definitions and time analysis of

267   practice activities; (5) establishing intra-observer reliability: to obtain test-retest reliability.

268   Three blocks of systematic observation took place: before the workshop (SOA1), directly after

269   the workshop (SOA2), and 3-months after the workshop (SOA3) with no formal coaching. In total, 84

270   coaching sessions were filmed across the three blocks. The coaching sessions took place within an

271   indoor training facility (40m x 40m) and were filmed using a digital video camera (Sanyo, Japan)

272   mounted on a stationary tripod (Libec, USA). The camera was located 10m from the coaching perimeter

273   such that all movements of the players and coaches could be viewed at all times. The video footage

274   from each coaching session was transferred to an Apple iMac computer (Apple, USA). The video

275   footage was analysed using Studio Code software (Sportstec, Australia) using continuous recording

276   method (Darst, Zakrajsek, & Mancini, 1989; Ford et al., 2010) for the amount of time spent in drill-

277   based and games-based activities, as well as transition. All analyses followed the procedure set out by

278   Brewer and Jones (2002) to ensure a valid systematic observation process. Two trained coders with

279   experience of systematic observation coded the coach practice activity data at separate times and

280   locations, allowing time to analyse all aspects of the video footage and to increase the validity and

281   reliability of the coding (Patton, 2002). The lead observer possessed the UEFA 'C' coaching license.

282   The two coders carried out inter-observer and intra-observer reliability agreements which were

283   calculated using the following observation: (agreements/ (agreements + disagreements)) x 100 (Darst

284   et al., 1989). Inter-observer and intra-observer reliability were 93% and 97% respectively, both of which

285   exceeded the minimum acceptable level of 85% (Darst et al., 1989).

286   The percentage of time that coaches spent in two main activities and transition were calculated

287   for each block of systematic observation. The data for the two main activities and transition violated

288   the statistical assumption of independence (Field, 2017). That is, when players spent a large amount of

289   time in one activity, they could only spend a small amount of time in the other activity. To address this

290   issue, and after first examining the mean values for each of the two main practice activities and

291   transition, the percentage of time spent in each was calculated, and analysed using three separate within-

292   subjects repeated measures ANOVAs, with systematic observation block as the repeated factor. *Post-*

293   *hoc* analysis on the related factor was carried out using Bonferroni comparisons. Statistical significance

294   was set at $p < 0.05$, and partial eta squared (η_p^2) expressed the size of the effect. To provide a description

295   of a significant difference between two means (i.e., pre-workshop to post-workshop), we calculated a

296   percentage change score (see Vincent & Weir, 2012) using for the following equation: ((post-workshop

297   – pre-workshop) / pre-workshop)) * 100.

298

299   Insert **Figure 1** and **Table 1** here.

300

301   *Coach interviews*

302   The use of interviews, alongside the systematic observation, provided an opportunity to

303   explore, and synthesise (with the *systematic observation data*) the perceptions from the coaches and

304   what motivated them to use certain practice activities (Partington & Cushion, 2013; Partington,

305   Cushion, & Harvey, 2014). This approach allowed us to better capture the complexity of the coaching

306   process and understand why coaches use certain practice activities (see Potrac et al., 2000; Potrac, Jones

307   & Armour, 2002; Partington & Cushion, 2013). The interviews were conducted after each block of

308   systematic observation (upper panel **Figure 1**). Interview A1 was designed to explore what the coaches

309   underlying rationale was for implementing the practice activities recorded in SOA1, and where the

310   coaches had acquired the knowledge to use these activities. Interview A2 was designed to explore why

311   coaches did or did not increase the %Time spent using games-based activities directly following the

312   CPD education workshop. Interview A3 occurred 3-months after the workshop and was designed to

313   explore why coaches continued to use and implement the practice activities discussed during the

314   workshop and implemented in SOA3 after a period of no formal coaching.

315   The semi-structured interview process was guided by the methods used by Partington and

316   colleagues (Partington & Cushion, 2013; Partington, et al., 2014). The lead interview questions were

317   developed deductively based on the systematic observation data recorded from SOA1, SOA2 and SOA3

318   plus evidence from skill acquisition literature (Williams & Hodges, 2005) and data related to the

319   practice activities used by soccer coaches (Ford et al., 2010; Partington & Cushion, 2013). The

320   interview process combined the use of open, and probe, questions to fully explore the topic of

321   questioning until a saturation point (Patton, 2002; 2014) was reached by a coach (i.e., no new

322   information was being provided during the discussion; see Glaser & Strauss, 1967). This questioning

323   style allowed participants to provide rich accounts of their experiences and perceptions to the question

324   posed by interviewer (Patton, 2002; 2014). Similar questions were asked to all coaches in order to

325   ensure consistent responses were provided in terms of depth and complexity to the question (Patton,

326   1990). In Interview A1 (lasted between 8-19 minutes), a simulated recall method was used to encourage

327   coaches to talk. This involved the interviewer presenting coaches with diagrams and seven videos on a

328   laptop that displayed the practice activities that they had employed during the coaching sessions filmed

329   from SOA1. The activities were selected to include one example of each of the seven sub-activity types

330   defined in **Table 1**. Activities were selected using the 'most frequently used' or when frequency was

331   equal, a 'typical example' of that activity. Following this, the coaches were asked: (1) "*What are your*

332   *reasons for using this activity?*" (2) "*Where did you first acquire that activity from?*" In Interview A2

333   (lasted between 4-14 minutes), the mean percentage of drill-based and games-based activities from

334   SOA2 were provided to each coach. Comparisons were made between the percentages calculated from

335   the two activities employed in SOA1 and SOA2. If the %Time spent using games-based activities had

336 significantly increased, the coaches were then asked: "*We are interested in knowing your reasons for*

337 *using more games-based activities in your coaching sessions that followed the CPD session?*"

338 Following their first answer, a prompt question was stated: "*Were there any other factors that led to*

339 *there being an increase?*" If the %Time spent using games-based activities had increased by less than

340 10%, then the coaches were also asked: "*What were your reasons for not using more games-based*

341 *activities?*" Subsequently, following their answer, a prompt question was stated: "*Were there any other*

342 *reasons for you not using more games-based activities?*" If the %Time spent using games-based

343 activities had not increased, then a coach was asked: "*We are interested in knowing your reasons for*

344 *not using more games-based activities in your coaching sessions after the CPD session?*" Following

345 their first answer, a prompt question was asked that stated: "*Were there any other factors that led to*

346 *there being no increase?*" The Interview A3 (lasted between 3-10 minutes) procedure followed the

347 same processes used in Interview A2, but were related to the 3-month delayed period.

348   Interview data were collected via a digital audio voice recorder (Olympus, Japan) and then

349 transcribed using natural speech and syntactic markers. First, a member of the research team (the

350 interviewer) became immersed in the data by reading and re-reading the individual interview

351 transcripts, plus annotated any initial observations. The analysis process began deductively (Patton,

352 2002; 2014), where categories and subcategories were identified based on the lead interview questions,

353 scientific evidence from skill acquisition studies (e.g., Williams & Hodges, 2005), practice activities

354 used by soccer coaches (Ford et al., 2010; Partington & Cushion, 2013), and the systematic observation

355 data recorded from Blocks A1, A2 and A3. Whilst carrying out this process, inductive categories and

356 subcategories emerging from the data were also noted and recorded. To reduce personal bias that a

357 single researcher may bring and thus establish further trustworthiness (Silverman, 2001; Graneheim &

358 Lundman, 2004), these two category types were discussed and finalised by all members of the research

359 team. To further ensure trustworthiness, a copy of the data (coach names were removed) was read by

360 the HSSM to establish credibility of the findings through a stakeholder check (Patton, 2002). No issues

361 were raised. Consistent with previous research (Sparkes, 1998; Partington & Cushion, 2013), example

362 quotations were used to present the main categories and subcategories for each lead question. After the

363 initial analysis, and similar to the systematic observation data, in order to further establish trust and to

364   assure the validity and reliability of the analysis, inter and intra-observer agreements were calculated.

365   In order to do this, a third-party coder was trained in the same analysis procedure as described and asked

366   to analyse an example transcript from each coach interview. Their analysis was compared to the main

367   analysis to measure agreements and disagreements in the thematic coding. Inter-observer and intra-

368   observer reliability were calculated as 94% and 96%, respectively (Darst et al., 1989). The results of

369   the validity and reliability tests were discussed by all members of the researcher team, an independent

370   member of the research team, as well as the HSSM. The aforementioned have experience in skill

371   acquisition, practice activities, and interviews, and collectively this enabled us finalise the emergence

372   of appropriate categories and subcategories.

373

374   **Results**

375   *Systematic observation data*

376   The mean percentage (%) time spent using drill-based activities, games-based activities, and

377   transition are illustrated in **Figure 2**. For drill-based activities (white bars), the ANOVA revealed no

378   significant differences [$F(2, 12) = 1.53$, $p = 0.26$, $\eta_p^2 = 0.24$] in the %Time coaches spent using these

379   activities across the three (pre-, post-, delayed-) workshop blocks. A significant [$F(2, 12) = 5.29$, $p =$

380   0.02, $\eta_p^2 = 0.47$] difference was revealed for %Time spent using games-based activities (dark-grey bars),

381   with coaches significantly ($p < 0.05$) increasing (the difference equated to a percentage change score of

382   17%) the use of these activities from pre-workshop (M= 31.52, SD = 14.64) to post-workshop (M =

383   48.03, SD = 18.44). Importantly, there was no significant ($p > 0.05$) difference in %Time spent using

384   games-based activities from post-workshop to delayed-workshop (M = 40.08, SD = 14.94). For

385   transition, a significant [$F(2, 12) = 3.78$, $p < 0.05$, $\eta_p^2 = 0.32$] difference was revealed with coaches

386   spending significantly ($p < 0.05$) less time (the difference equated to a percentage change score of 5%)

387   in transition in the post-workshop (M = 19.33, SD = 3.73) compared to the pre-workshop (M = 24.42,

388   SD = 5.60). There was no significant ($p > 0.05$) difference in %Time spent in transition from post-

389   workshop to delayed-workshop (M = 19.54, SD = 4.97).

390

391   Insert **Figure 2** near here.

392

393   *Interview data*

394   Thematic analysis data are presented in **Table 2** and illustrate the reasons that coaches used (a)

395   drill-based and (b) games-based activities in their coaching sessions pre-workshop, and where they

396   acquired the knowledge to use these activities (**Table 3**). For the use of drill-based activities, the main

397   categories included: (1) greater opportunity to develop certain technical skills (e.g., passing) through

398   repetition without any opposition; (2) forming part of the warm-up, allowing players to become

399   comfortable with the ball, together with developing fundamental movement skills; (3) allowing players

400   to feel comfortable with executing the skill before introducing opposition; (4) and coaches' perceptions

401   that their players enjoy some of the drill-activities. These activities were typically acquired from *other*

402   *coaches* (37%)*, created on own* (16%), and a combination of *other coaches and created on own* (11%).

403   For the use of games-based activities, the main categories included: (1) opportunities to develop

404   tactical knowledge that may have been identified based upon previous competition/sessions; (2) the

405   activity was a progression of an earlier activity to more closely replicate the demands of the game; (3)

406   providing greater opportunities to develop their players decision-making; (4) previous positive

407   experiences from engaging in similar activities during coaching licenses (e.g., UEFA 'B') courses; (5)

408   and providing greater opportunities to assess their players learning around the main focus/aim of the

409   session. These activities were typically acquired from *other coaches* (20%)*, created on own* (15%), and

410   *coach education courses* (40%).

411

412   Insert **Table 2** and **Table 3** near here.

413

414   Thematic analysis data are presented in **Table 4** and illustrate the reasons that coaches

415   increased or maintained the percentage use of games-based activities in their coaching sessions post-

416   workshop. From the five coaches that increased the percentage use of games-based activities, the main

417   categories included: (1) implementing the evidence-based principles discussed in the CPD workshop;

418   (2) the coaches observations of how much more their players enjoyed the games-based activities; (3)

419   players are more motivated (i.e., effortful); (4) and providing opportunities to develop their players

420   skills such as decision-making, as well as opportunities to assess their players ability to adapt to the

421   increased attentional demands consistent with match-play. From the two coaches that maintained the

422   percentage use of games-based activities, the only category was: (1) drill-based activities were

423   sometimes required to better 'breakdown' the technical skill.

424

425   Insert **Table 4** near here.

426

427   Thematic analysis data are presented in **Table 5** and illustrate the reasons that coaches

428   decreased or maintained the percentage use of games-based activities in their coaching sessions

429   delayed-workshop. From the five coaches that decreased the %Time spent using games-based activities,

430   the main categories included: (1) conflicting information that was provided in an external workshop

431   during the 3-month period; (2) constraints associated with the total session time, as well as the use of a

432   new curriculum to meet the requirements of the EPPP; (3) the difficulty of progressing from the main

433   theme of the session to a game-based activity. From the two coaches that maintained the %Time spent

434   using games-based activities, the main categories included: (1) continuing to implement the evidence-

435   based principles discussed in the CPD workshop; (2) the topics associated with the club curriculum

436   being more engaging through the use of games-based activities; (3) providing greater opportunities

437   compared to drill-based activities to develop their players skills.

438

439   Insert **Table 5** near here.

440

441   **Discussion**

442   Consistent with previous work in soccer (Ford et al., 2010; Partington & Cushion, 2013), the

443   pre-workshop systematic observation data (SOA1) indicated that the coaches spent more time using

444   drill-based, compared to games-based, activities. Whilst drill-based activities are typically used by

445   coaches to facilitate the development of soccer related technical skills (Ford et al., 2010), they are

446   suggested to limit the development of motor and perceptual-cognitive processes needed for dynamic

447 match-play (Ford et al., 2010). Importantly, the post-workshop data indicated that coaches increased

448 (17%, **Figure 2**) the time spent using games-based activities across all age groups following the

449 evidence-based CPD educational workshop. Although we might have expected a reduction in drill-

450 based activities, we in fact observed that coaches decreased the amount of time spent in transition

451 (period of time moving between activities) by 6%. Therefore, the decision to reduce transition time

452 seems to have been made to allow more time to implement the games-based activities from the

453 intervention, which is a positive outcome as it provided academy players with extra time in games-

454 based activities to develop important motor and perceptual-cognitive processes needed for dynamic

455 match-play. To examine whether the coaches continued to use any changes in practice activities, we

456 employed a third block of systematic observation after a 3-month delayed period (SOA3). Although

457 there was a slight decrease in the amount of time spent in games-based activities, this remained above

458 pre-workshop data (32%) and therefore indicated that the modulation of practice activities employed

459 by coaches across the first two blocks of the study remained suggesting some level of learning.

460   The significant increase observed in the amount of time spent in games-based activities

461 supported our hypothesis that the practice activities delivered in soccer coaching sessions can be

462 influenced by engaging coaches in evidenced-based CPD educational workshops that are co-created.

463 Following the workshop, coaches adopted more games-based activities (e.g., 4 v 4 phase of play) that

464 have the potential to develop the acquisition of motor and perceptual cognitive processes (Williams &

465 Hodges, 2005; Ford et al., 2010) that can be transferred by players from the coaching sessions to match-

466 play. The data recorded from the coaches during interpretive interviews indicated that one of their main

467 motivations for modifying coaching behaviour was the evidence-based information discussed during

468 the intervention. For example, "*Obviously from the CPD, the guy who went through it told us rather*

469 *than breaking it down and doing one-on-one and bring it down to it rawest form, you're better doing*

470 *those sorts of situations in game time*" (C1). Taken together, these data illustrate that practice activities

471 adopted by professional soccer coaches can be modulated through co-creative interventions, which

472 seems to be an effective way of closing the gap between science and application (Cushion et al., 2012).

473   Although we found these positive effects for games-based activities, it is important to

474 acknowledge that this came at the cost of a reduction in transition time, which could have impacted the

475   opportunity for players to receive instructions and feedback that are important for skill acquisition (Ford

476   et al., 2010; Salmoni, Schmidt, & Walter, 1984), plus hydration and recovery (Nédélec, et al., 2012).

477   Therefore, the fact that the amount of time spent in drill-based activities was not significantly different

478   (**Figure 2**) across the study offers an opportunity to examine whether this area of coaching behaviour

479   can also be changed by targeted interventions that modify drill-based activities to contain aspects of

480   decision-making as per those employed in games (Ford & Whelan, 2016). The interpretive interview

481   data suggests that the main reasons for using drill-based activities was to develop technical skills, warm-

482   up sessions, progression of the drill and perceived player enjoyment (see **Table 2**). In our previous work

483   in cricket (Low et al., 2013), we made specific suggestions for how drill-based activities employed by

484   coaches could be modified to contain elements of 'active' decision-making, and therefore be

485   categorised as games-based because they would require players to make decisions based on the

486   positioning of teammates, space, and opposition formations (Williams & Ford, 2013). Whilst these

487   active decision-making drills have the potential to facilitate the acquisition of both motor (i.e., technical)

488   and perceptual-cognitive skills, it is likely that some coaches may require help from applied sport

489   scientists and researchers in order to develop these practice activities (Ford et al., 2010; Cushion et al.,

490   2012; Low et al., 2013). Therefore, a follow-up CPD educational workshop was conducted within the

491   same club (see In Experiment B) in an attempt to modify the practice activities used by coaches to

492   include active decision-making. To explore the efficacy of different educational CPD methods, we

493   adopted a video-based feedback based methodology instead of the paper booklet used in Experiment A

494   because it has been shown within an educational context to change coaches' non-verbal behaviours

495   (Meeûs, Serpa, & De Cuyper, 2010), and soccer coaches and players have had positive experiences

496   from engaging with video-based feedback when working on professional development and coaching

497   practice (Groom & Cushion, 2004; Raya-Castellano et al., 2020).

498   To this end, in the follow-up Experiment B we aimed to investigate whether providing coaches

499   with a co-creative workshop involving video-based feedback would modulate the practice activities

500   used by coaches resulting in an observed increase in drills that contain active decision-making. As per

501   Experiment A, first we first engaged in informal meetings with key stakeholders in order to co-create

502   the video-based intervention. Following this discussion, a six-phase experimental protocol was

503   employed (lower panel **Figure 1;** Note: no delayed phase was conducted in Experiment B as two

504   coaches, as well as the HSSM, left the club over the summer period). Second, and third, we adopted

505   similar methods of systematic observation of coaching sessions (SOB1), and coach interviews

506   (Interview B1). Fourth, for the workshop, a roundtable (as per Experiment A) discussion with the

507   coaches was employed that focused on the observation and appraisal of videos that contained pre-

508   workshop practice drill-based activities, as well as videos of example drill-based activities that had been

509   manipulated to contain active decision-making (see methods). Fifth and sixth, following the workshop,

510   a second block of systematic observation (SOB2) and interview (Interview B2) were carried out. It was

511   predicted that across experimental phases, a significant increase in activities that contained active

512   decision-making would be adopted by coaches following the co-created intervention.

513

514   <u>Experiment B</u>

515   ***Participants***

516   All participants from Experiment A were recruited for Experiment B.

517

518   ***Co-creation process***

519   As per Experiment A, the implementation of a co-created educational workshop was discussed

520   during a meeting at the soccer club between the lead author and the HSSM (lower panel **Figure 1**).

521

522   ***Coach education workshop***

523   We used the same general procedures to those used in Experiment A when developing and

524   running the CPD educational workshop. Specifically, rather than using a technical report to form the

525   discussion process, we used a soccer-based video intervention. First, the coaches were provided with

526   the definitions (see **Table 6**) of active, and non-active, decision-making activities and offered a chance

527   to discuss these amongst themselves, followed by an opportunity to seek clarity from the last author

528   (SH). To contextualise these written definitions, the coaches watched the soccer-based video that was

529   created to show a battery of video examples that illustrated soccer drills that had been manipulated to

530   contain active decision-making. These active decision-making soccer activities were devised by the

531   second and last author, and further developed and refined with consultation from the HSSM, and the

532   AD. Once finalised, and in order to create the video, the activities were simulated by a group of players

533   from a squad (U18s) within the youth academy. The players performed the simulated coaching sessions

534   on the training pitches at the academy wearing the club kit. The sessions were ran by the HSSM, and

535   the AD, and were filmed using the same general filming protocol and apparatus as in Experiment A.

536   The simulated active decision-making sessions were then edited to create the in-house soccer-based

537   video workshop. Second, during the actual intervention, the coaches watched the individual videos, and

538   then discussed the scenarios amongst themselves in relation to the written definitions. The discussion

539   was facilitated and developed with input from the last author, the HSSM, and the AD. The coaches

540   were then asked to try and implement what was covered in the workshop across the next block of

541   coaching sessions filmed in the study (SOB2).

542

543   *Systematic observation*

544   As per in the lower panel of **Figure 1**, two blocks of systematic observation took place. In total,

545   50 coaching sessions were filmed across the two blocks. We used the same general filming protocol,

546   apparatus, and analysis as Experiment A. Importantly, however, we created new categories for the

547   soccer practice activities used in the analysis: active decision-making, non-active decision-making,

548   fitness and transition (see **Table 6**). For active decision-making, the categories used by coaches required

549   elements of decision-making (e.g., the main action execution decision/s for the player/s in possession

550   must have at least two or more options, usually involving moving opposition who make the requirement

551   for that decision. In the systematic observation analysis, we quantified the following: drills with an

552   active decision-making component; small-sided games; unidirectional games; phase of play;

553   conditioned small-sided-games; possession games). For non-active decision-making, the decision was

554   specified/constrained to the player within the drill (e.g., the main action execution had only one option

555   that was usually pre-determined by the coach such as a 10m driven pass to a partner). Inter-observer

556   and intra-observer reliability from the systematic observations were 96% and 98% (Darst et al., 1989).

557   The percentage of session duration that players spent in the two categories of active decision-

558   making and non-active decision-making, as well as the transition and fitness, was calculated for each

559 block of systematic observation. This was calculated using the same method as in Experiment A. The

560 data for the two main practice activities, fitness and the transitions violated the statistical assumption of

561 independence (Field, 2017). Again, after first examining the mean values for each of the two main

562 practice activities, fitness and transition, the percentage of session duration spent in each variable in the

563 pre-workshop and post-workshop were analysed using separate one-tailed *t*-tests. Statistical

564 significance was set at $p < 0.05$ and Cohen's *d* expressed the size of the effect.

565

566 Insert **Table 6** near here.

567

568 ***Coach interviews***

569 Semi-structured interpretive interviews were conducted after each block of systematic

570 observation (one coach was unavailable after the second block of systematic observation). In the first

571 interview, examples of non-active decision-making activity were shown, the questions asked for each

572 of the activities were: (1) "*What are your reasons for using this activity?*" (2) "*Where did you first*

573 *acquire that activity from?*" In the second interview, the mean percentage data for active decision-

574 making, non-active decision-making, fitness and transition was provided. Comparisons were made

575 between percentages in SOB1 and SOB2. If the %Time spent using activities with non-active decision-

576 making had decreased, coaches were asked: "*We're interested in knowing your reasons for using less*

577 *non-active decision-making activity in your coaching sessions that followed the CPD session?*"

578 Following their first answer, a prompt question was stated: "*Were there any other factors that led to*

579 *there being a decrease?*" If the %Time spent using activities with non-active decision-making had not

580 changed, then coaches were asked: "*What were your reasons for using the same amount of non-active*

581 *decision-making activity in your coaching sessions after the CPD?*" Subsequently, following their

582 answer, a prompt question was stated: "*Were there any other reasons for you using the same amount of*

583 *non-active decision-making activity?*" In the instances where the %Time spent using activities with

584 non-active decision-making had increased, then coaches were asked: "*We're interested in knowing your*

585 *reasons for not using less non-active decision-making activity in your coaching sessions after the CPD*

586 *session?*" Following their first answer, a prompt question was asked that stated: "*Were there any other*

587   *factors that led to there being no decrease?*" Coaches were then asked question regarding their

588   understanding of the intervention: "*From your understanding, what was the purpose of this session's*

589   *CPD?*" and whether they had a preference for either delivery method used: "*You have now been*

590   *involved in two CPD sessions with us. The first involved a formal delivery of the material. The second*

591   *was a more interactive session that used video footage to stimulate discussion. Do you have any*

592   *comments regarding these two different delivery methods?*" Prompt questions were used throughout to

593   encourage coaches to expand where needed.

594   Interview data was processed and analysed as per Experiment A. Inter-observer and intra-

595   observer reliability were 90% and 97% respectively (Darst et al., 1989).

596

597   **Results**

598   *Systematic observation data*

599   The mean percentage (%) time spent using active decision-making, non-active decision-

600   making, transition, and fitness are illustrated in **Figure 3**. The %Time spent using activities with active

601   decision-making (white bars) in the pre-workshop (M = 63.41, SD = 14.7) sessions was significantly

602   [$t(6) = 3.03$, $p = 0.01$, $d = 1.16$] different to the %Time spent in the post-workshop (M = 76.57, SD =

603   6.33) sessions (this difference equated to a percentage change score of 13%). For activities with non-

604   active decision-making (light-grey bars), the %Time spent used in the pre-workshop (M = 14.22, SD =

605   12.49) was significantly [$t(6) = 2.37$, $p = 0.03$, $d = 1.04$] different to the %Time spent used in the post-

606   workshop (M = 4.72, SD = 3.20) sessions (this difference equated to a percentage change score of 9%).

607   There were no significant differences observed from pre-to-post workshop for transition [$t(6) = 1.58$, p

608   = 0.08, $d = 0.60$; see dark-grey bars] or fitness [$t(6) = 0.72$, $p = 0.25$, $d = 0.32$; see black-bars]. Because

609   the active decision-making dependent variable contained multiple activities (where the main action

610   contains two or more degrees of freedom or options, see **Table 6** and Low et al., 2013) that were

611   measured during the systematic observation, we performed an additional analysis to further explore the

612   active decision-making effect. Here, and based on the descriptive analysis, we focused on two active

613   decision-making activities: drills with active decision-making, and small-sided games. The analysis

614   indicated no significant difference from pre-to-post workshop for the amount drills used with active

615   decision-making [$t(6) = 1.7$, $p = 0.14$, $d = 0.94$], but, the %Time spent using small-sided games in post-

616   workshop was significantly [$t(6) = 0.72$, $p = 0.03$, $d = 1.32$] different (i.e., higher) than %Time spent in

617   the pre-workshop sessions (this difference equated to a percentage change score of 23%).

618

619   Insert **Figure 3** near here.

620

621   *Interview data*

622   Thematic analysis data are presented in **Table 7** and illustrates the reasons that coaches used

623   activities with non-active decision-making in their coaching sessions pre-workshop, as well as where

624   they acquired these activities (**Table 8**). The main categories included: (1) more opportunities to

625   observe and subsequently develop all their players technical skills within a short period of time; (2)

626   forming part of the warm-up, where players performed fundamental movement skills; (3) progression

627   of the skill to move into a game; (4) the coaches observations of how much players enjoyed activities

628   which the coach perceived as 'dull'; (5) repetition of the skill providing more opportunities to develop

629   and progress the skill. These activities were typically acquired from *creating on own* (33%), *coach*

630   *education courses* (24%)*,* and *other coaches* (10%).

631

632   Insert **Table 7** and **Table 8** near here.

633

634   Thematic analysis data are presented in **Table 9** and illustrates the reasons that coaches

635   increased the percentage use of active decision-making activities in their coaching sessions post-

636   workshop. The main categories included: (1) implementing the evidence-based principles discussed in

637   the CPD education workshop; (2) opportunities for the coaches to develop their players decision-

638   making skills; (3) the ease of implementing activities that contain elements of active decision-making

639   due through modifying previous practice activities/sessions; (4) coupled with new larger facilities (i.e.,

640   pitch size).

641

642   Insert **Table 9** near here.

643

644   Thematic analysis data are presented in **Table 10** and illustrates the perceptions of the coaches

645   as to the purpose of the workshops. The main categories included: (1) increasing the opportunities for

646   their players to develop decision-making skills; (2) to modify their sessions such that they closely

647   replicated the demands of the game (i.e., "…more realistic,"); (3) decreasing the amount of time spent

648   in activities that are unopposed; (4) providing more practice time for their players and ensuring a greater

649   chance of player retention (i.e., increasing player attendance); (5) provide opportunities to develop their

650   coaching practice; (6) and receive feedback of their coaching sessions.

651

652   Insert **Table 10** near here.

653

654   Thematic analysis data are presented in **Table 11** and illustrates the preferences of the coaches

655   as to the use of the video-based workshop in Experiment B compared to the standard workshop in

656   Experiment A. From the five coaches that preferred the interactive video-based delivery style, the main

657   categories included: (1) the video style helped coaches to see where (i.e., pre-workshop examples), and

658   how (i.e., U18s simulated activates), they could modify their practice activities; (2) opportunities to

659   discuss their own and other coaches practice activities; (3) greater opportunities to retain the

660   information from the workshop; (4) videos from their own club (i.e., U18s) allowed for a more personal

661   learning experience. From the one coach that had no preference, the only category was: (1) both

662   workshops developed their coaching practice.

663

664   Insert **Table 11** near here.

665

666   **Discussion**

667   Consistent with our hypothesis, results from Experiment A (i.e., pre-workshop drill-based

668   activity data), and the scientific literature (Williams & Hodges, 2005; Ford et al., 2010), the workshop

669   data from Experiment B indicated that coaches spent more time employing coaching session activities

670   that contained non-active decision-making (**Figure 3**). Whilst this form of coaching session(s) is not

671   always optimal for developing the processes that are typically used in dynamic soccer games, the post-

672   workshop data indicated that coaches employed significantly more sessions containing active decision-

673   making. Specifically, the subsidiary analysis provided a greater insight into this effect by showing that

674   coaches opted to significantly change the percentage of small-sided games used in post-workshop.

675   Similar to the development of games-based activities in Experiment A, the fact that we replicated this

676   development in the form of 'active-decision making' is important because it is likely to have provided

677   the players with an opportunity to acquire motor and perceptual-cognitive skills that closely replicate

678   the demands of the game, and which would hopefully facilitate transfer to match-play (Ford et al.,

679   2010). The interpretive interview data indicated that the coaches reported the workshop was one

680   motivating factor for implementing more 'active-decision making' activities. For example, Coach 7

681   stated: "*It was just seeing how much, obviously the ideal thing we want to do is have the kids making*

682   *as many decisions as possible. So, we took that on board and tried to put it into all the sessions, whether*

683   *it be the warmup, whether it be the cool down at the end or the main chunk of the session. Just trying*

684   *to make sure the kids have as many decisions to make as possible*" (**Table 9**). What is noteworthy is the

685   fact that the coaches decided to increase the use of small-sided games, rather than specific drill-based

686   activities that contained active decision-making (Low et al., 2013). Importantly, there was no difference

687   in the percentage of time in transition where other important aspects of coaching are often implemented

688   such as instruction and feedback, and hydration. As reported by Coach 7 in the previous quotation, it

689   seems that in Experiment B, the underlying principles of the video-based workshop (i.e., 'active-

690   decision making') were implemented across the whole coaching session (e.g.," *Just trying to make sure*

691   *the kids have as many decisions to make as possible.*").

692

693   **General discussion**

694   The two-experiment study was designed to examine whether practice activities adopted by

695   professional youth soccer coaches could be modulated and adapted by actively engaging coaches in

696   CPD educational workshops that were based on scientific evidence. Data from Experiment A and B

697   indicated that coaches significantly increased the percentage of time employing games-based (i.e.,

698   small-sided/conditioned games), and active decision-making activities after engaging in a standard

699 (roundtable), or enhanced (video feedback) interactive, CPD educational workshop involving coaches

700 and a researcher from an external partner institution. What was particularly important from a

701 methodological perspective was after a 3-month period away from the club the coaches continued to

702 use the level of games-based activities observed post-workshop (see **Figure 2**). By not returning to pre-

703 workshop levels indicates that the modulation of practice activities was retained resulting in a relatively

704 permanent change in coach behaviour. Although our study was quite short, the change behaviour effect

705 supports the idea that longitudinal approaches might be an effective workshop strategy for modulating

706 practice activities in coaching (Harvey et al., 2010).

707 The increase we observed in the amount of the time spent by coaches using games-based

708 activities, and/or activities that contained active-decision making, have the potential to provide players

709 with a greater opportunity to develop motor and perceptual-cognitive skills such as visual search,

710 anticipation, and decision-making (Ford & Williams, 2013), which are central to expert performance in

711 sport (Williams & Reilly, 2000; Ford et al., 2010). Although data from lab-based, or controlled

712 simulated games-based, studies show that motor and perceptual-cognitive skills can transfer to match-

713 play (Williams & Hodges, 2005; Ford et al., 2010), the data from our two experiments extends this

714 work by showing that the underlying skill acquisition principles from lab-based studies can be delivered

715 via CPD educational workshops to promote behaviour change in coaches. Data from the interviews

716 indicated that the coaches supported the use of these workshops, with the coaches suggesting the

717 feedback and active CPD educational workshop process was a motivating factor for changing their

718 behaviour. Whilst it has consistently been reported (Williams & Hodges, 2005; Gilbert et al., 2009;

719 Cushion et al., 2012; Partington & Cushion, 2013) that coaches develop their knowledge from

720 emulating other coaches, and modifying their own practice, rather than from using evidence from

721 science, the current study shows these 'traditional' practice activities can be modified via education.

722 The significnat changes we observed across both studies is important evidence showing that

723 'bridging the gap' between science and application (Ford et al., 2010; Cushion et al., 2012; Low et al.,

724 2013) can be achieved by engaging clubs with sport scientists and researchers to 'co-create' CPD

725 education workshops. By adopting this pedagogical approach, we believe that we removed some of the

726 barriers that typically impact the transfer of scientific knowledge to application such as researchers not

727   considering the interests of coaches (e.g., sport psychology; Williams & Kendall, 2007), as well as the

728   difficulties that some coaches may experience accessing and integrating scientific evidence into their

729   own coaching practice (Martindale & Nash, 2013). The co-creation method used in the present study

730   was designed specifically to develop a professional working relationship with key members of the

731   academy, that being the HSSM and AD. This relationship enabled us to develop workshops that met

732   the needs of the club but was also underpinned by our expertise in science and motor behaviour.

733   Moreover, we were motivated as a team to work very closely with the club in order to take into

734   consideration the outlined needs and philosophy such that all working parameters and goals were

735   attained. The information from many roundtable discussions informed, via 'co-creation', the basis of

736   the research question, methodology, workshop and ethics. This approach also developed a learning

737   environment within the CPD educational workshops that seemed to increase engagement in the

738   workshop, whereby informed discussions between the coaches, club staff, and the researcher was

739   similar to typical methods of how soccer coaching knowledge is acquired (i.e., emulation) and thus

740   resulted in greater engagement ('buy-in') from coaches (Stoszkowski & Collins, 2016). We are mindful

741   however that the rationale, and generation of the CPD educational workshops, that led to these changes

742   were initially developed without the direct involvement from the coaches, and/or players. Whilst this

743   approach was not a deliberate strategy based on a predefined organisational hierarchy, we do recognise

744   the multifactorial nature of the specific social-sporting environment (see 'activity theory in sports

745   coaching' forwarded by Jones, Edwards, & Viotto Filho, 2016) and acknowledge the potential benefits

746   to player development and performance based on a more conjoined approach that values the viewpoints

747   from invested parties (i.e., players, coaches, researchers, academy heads etc).

748   Although the two CPD co-creative workshops successfully modified coach practice activities

749   via behaviour change, the subsidiary analysis indicated that drills that contain active decision-making

750   (Low et al., 2013) were not significantly changed across the workshop. Based on our experience (Low

751   et al., 2013), it might be that coaches opted to use small-sided games as opposed to bespoke active

752   decision-making drills as there was more scope, or it was easier, to change/modify these types of games

753   from their own coaching repertoire. A method that could be implemented to increase the number and

754   soccer specificity of active decision-making drills is to upskill and support coaches (and perhaps

755   players) by developing mentorship programmes (Cushion, 2015; Dawson, 2014; Jones, Harris, & Miles,

756   2009) that target specific aspects of coaching practice, and/or at particular stages [e.g., a youth

757   development coach has very different needs ('technical detail') to an elite ('micro-politics') coach] of

758   a coach's career (Leeder & Sawiuk, 2020). For example, junior Australian soccer coaches significantly

759   changed the delivery type of practice sessions employed in youth coaching (i.e., increased use of playing

760   form), and coach behaviours (i.e., increase in positive coaching behaviours related to verbal feedback),

761   following a 15-week multi-approach intervention that contained face-to-face workshops, ongoing

762   mentoring, modelled training sessions, peer assessments, and group discussions (Eather et al., 2020).

763   This intervention was deemed beneficial because it was high-dosage (15-weeks), rather than low-

764   dosage (i.e., one session as per our workshop), which indicates that mentorship schemes should

765   carefully consider the length and structure of the programme. Perhaps more importantly is the fact that

766   soccer environments are typically complex and constrained by many interacting personal-social-

767   sporting-environmental factors, which means that mentorship programmes are not a one-size fits all

768   mechanism and therefore should consider these multiple factors in design. Indeed, it has been suggested

769   (Leeder & Sawiuk, 2020) that effective mentoring schemes should consider implementing multiple-

770   mentors [to cover different domain (e.g., cross-sport; sport v non-sport) areas of expertise],

771   developmental networks mentorships, technology and e-learning, interpersonal skills training, mentor

772   learning programmes, gender representation, and culture.

773   To conclude, across two experiments we have shown that practice activities adopted by

774   professional youth soccer coaches can be influenced and changed in accordance with the evidenced-

775   based information (increase in games-based and active decision-making activities) (Ford et al., 2010),

776   thus closing the gap between science and application that exists in soccer coaching (Williams & Hodges,

777   2005). This was achieved through coaches and applied reserchers working together to 'co-create'

778   evidence-based CPD educational workshops (Ford et al., 2010; Cushion et al., 2012; Partington &

779   Cushion, 2013). By working closely with key stakeholders prior to the workshop, the needs and

780   philosophy of club were understood, a working and trusting relationship was developed, and the

781   working parameters were set out. The fact that the delayed-workshop data indicated the increase in

782   games-based activities did not return to pre-workshop levels, suggested some level of learning as the

783   coaches opted to use the new adapted practice activities after a 3-month period of no formal coaching.

784   We propose that co-creating sports-specific evidence-based multi-factorial workshops via conjoined

785   working relationships with players, professional coaches and stakeholders could be an effective tool for

786   facilitating behaviour change in coaches leading to benefits in player development and performance.

787

788   **References**

789   Brewer, C. J., & Jones, R. L. (2002). A five-stage process for establishing contextually valid systematic

790   observation instruments: The case of rugby union. *Sport Psychologist, 16*(2), 138-159.

791   Broadbent, D. P., Causer, J., Ford, P. R., & Williams, A. M. (2015). Contextual interference effect on

792   perceptual–cognitive skills training. *Medicine & Science in Sports & Exercise*, *47*(6), 1243-

793   1250.

794   Cassidy, T.G., Jones, R.L. & Potrac, P. (2008). Understanding sports coaching: The social, cultural and

795   pedagogical foundations of coaching practice. London, UK: Routledge.

796   Cassidy, T., & Rossi, T. (2006). Situating learning: (Re)examining the notion of apprenticeship in coach

797   education. *International Journal of Sports Science & Coaching*, *1*(3), 235-246.

798   Cope, E., Partington, M., & Harvey, S. (2017). A review of the use of a systematic observation method

799   in coaching research between 1997 and 2016. *Journal of Sports Sciences*, *35*(20), 2042-2050.

800   Cushion, C., & Jones, R. L. (2001). A systematic observation of professional top-level youth soccer

801   coaches. *Journal of Sport Behaviour*, *24*(4), 354-376.

802   Cushion, C., Armour, K. M., & Jones, R. L. (2003). Coach education and continuing professional

803   development: Experience and learning to coach. *Quest, 55*(3), 215-230.

804   Cushion, C., Ford, P. R., & Williams, A. M. (2012). Coach behaviours and practice structures in youth

805   soccer: Implications for talent development. *Journal of Sports Sciences, 30*(15), 1631-1641.

806   Cushion, C. (2015). Mentoring for success in sport coaching. In F. C. Chambers (Ed.), *Mentoring in*

807   *physical education and sports coaching* (pp. 155-162). London, UK: Routledge.

808   Darst, P. W., Zakrajsek, D., & Mancini, V. H. (1989). *Analyzing physical education and sport*

809   *instruction*. Champaign, IL: Human Kinetics.

810   Dawson, P. (2014). Beyond a definition: Toward a framework for designing and specifying mentoring

811   models. *Educational Researcher, 43(3),* 137-145.

812   Eather, N., Jones, B., Miller, A., & Morgan, P. J. (2020). Evaluating the impact of a coach development

813   intervention for improving coaching practices in junior football (soccer): The "MASTER" pilot

814   study. *Journal of Sports Sciences*, *38*(11-12), 1441-1453.

815   Field, A. (2017). *Discovering statistics using SPSS*. London, UK: Sage Publications.

816   Ford, P. R., Yates, I., & Williams, A. M. (2010). An analysis of practice activities and instructional

817   behaviours used by youth soccer coaches during practice: Exploring the link between science

818   and application. *Journal of Sports Sciences*, *28*(5), 483-495.

819   Ford, P. R., Carling, C., Garces, M., Marques, M., Miguel, C., Farrant, A., ... & Williams, M. (2012).

820   The developmental activities of elite soccer players aged under-16 years from Brazil, England,

821   France, Ghana, Mexico, Portugal and Sweden. *Journal of Sports Sciences*, *30*(15), 1653-1663.

822   Ford, P. R., & Williams, A. M. (2013). The acquisition of skill and expertise: The role of practice and

823   other activities. In. A. M. Williams (Ed.), *Science and Soccer, Developing Elite Performers*

824   (pp. 122-138). London, UK: Routledge.

825   Ford, P. R., & Whelan, J. (2016). Practice activities during coaching sessions in elite youth football and

826   their effect on skill acquisition. In W. Allison, A. Abraham, & A. Cale (Eds.), *Advances in*

827   *coach education and development: From research to practice* (pp. 112-123). London, UK:

828   Routledge.

829   Ford, P. R., Hodges, N. J., Broadbent, D., O'Connor, D., Scott, D., Datson, N., ... & Williams, A. M.

830   (2020). The developmental and professional activities of female international soccer players

831   from five high-performing nations. *Journal of Sports Sciences*, *38*(11-12), 1432-1440.

832   Fowler, C. A., & Turvey, M. T. (1978). Skill acquisition: An event approach with special reference to

833   searching for the optimum of a function of several variables. *Information processing in motor*

834   *control and learning*. In G. E. Stelmach (Ed.), *Information processing in motor control* (pp. 1-

835   40). New York, NY: Academic Press.

836   Franks, M. I., Hodges, N., & More, K. (2001). Analysis of coaching behaviour. *International Journal*

837   *of Performance Analysis in Sport*, *1*(1), 27-36.

838   Gilbert, W., Côté, J., & Mallett, C. (2006). Developmental paths and activities of successful sport

839   coaches. *Soccer Journal, 55*(3), 10-12.

840   Gilbert, W., Lichtenwaldt, L., Gilbert, J., Zelezny, L., & Côté, J. (2009). Developmental profiles of

841   successful high school coaches. *International Journal of Sports Science & Coaching, 4*(3), 415-

842   431.

843   Glaser, B., & Strauss, A. (1967). *The Discovery of Grounded Theory*. New Jersey, NJ: Routledge

844   Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: concepts,

845   procedures and measures to achieve trustworthiness. *Nurse Education Today, 24(2),* 105-112.

846   Greenwood, D., Davids, K., & Renshaw, I. (2012). How elite coaches' experiential knowledge might

847   enhance empirical research on sport performance. *International Journal of Sports Science &*

848   *Coaching*, *7*(2), 411-422.

849   Groom, R., & Cushion, C. (2004). Coaches perceptions of the use of video analysis: A case

850   study. *Insight*, *7*(3), 56-58.

851   Guadagnoli, M. A. & Lee, T. D. (2004). Challenge point: a framework for conceptualizing the effects

852   of various practice conditions in motor learning. *Journal of Motor Behavior, 36(2),* 212-224.

853   Hall, E. T., Gray, S., & Sproule, J. (2016). The microstructure of coaching practice: Behaviours and

854   activities of an elite rugby union head coach during preparation and competition. *Journal of*

855   *Sports Sciences, 34*(10), 896–905.

856   Handford, C., Davids, K., Bennett, S., & Button, C. (1997). Skill acquisition in sport: Some applications

857   of an evolving practice ecology. *Journal of Sports Sciences*, *15*(6), 621-640.

858   Harvey, S., Cushion, C. J., & Massa-Gonzalez, A. N. (2010). Learning a new method: Teaching games

859   for understanding in the coaches eyes. *Physical Education and Sport Pedagogy, 15*(4), 361-

860   382.

861   Jones, R. L., Armour, K. M. & Potrac, P. (2002). Understanding the coaching process: A framework

862   for social analysis. *Quest, 54(1)*, 34-48.

863   Jones, R. L., Harris, R., & Miles, A. (2009). Mentoring in sports coaching: A review of the

864   literature. *Physical Education and Sport Pedagogy*, *14*(3), 267-284.

865   Jones, R. L., Potrac, P., Cushion, C., & Ronglan, L. T. (2010). The sociology of sports coaching.

866   *Routledge*.

867   Jones, R. L., & Thomas, G.L. (2015). Coaching as 'scaffolded' practice: Further insights into sport

868   pedagogy. *Sports Coaching Review*, *4*(2), 65-79.

869   Jones, R. L., Edwards, C., & Viotto Filho, I. T. (2016). Activity theory, complexity and sports coaching:

870   An epistemology for a discipline. *Sport, Education and Society, 21(2)*, 200-216.

871 Lee, T. D., & Magill, R. A. (1983). The locus of contextual interference in motor-skill acquisition.

872 *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9(4),* 730-746.

873 Leeder, T. M., & Sawiuk, R. (2020). Reviewing the sports coach mentoring literature: A look back to

874 take a step forward. *Sports Coaching Review, 1-24*.

875 Low, J., Williams, A. M., McRobert, A. P., & Ford, P. R. (2013). The microstructure of practice

876 activities engaged in by elite and recreational youth cricket players. *Journal of Sports Sciences,*

877 *31*(11), 1242-1250.

878 Li, Y., & Wright, D. L. (2000). An assessment of the attention demands during random-and blocked-

879 practice schedules. *The Quarterly Journal of Experimental Psychology Section A, 53(2)*, 591-

880 606.

881 Martin, L. J., Turnquist, A., Groot, B., Huang, S. Y., Kok, E., Thoma, B., & van Merriënboer, J. J.

882 (2019). Exploring the role of infographics for summarizing medical literature. *Health*

883 *Professions Education*, *5*(1), 48-57.

884 Martindale, R., & Nash, C. (2013). Sport science relevance and application: Perceptions of UK

885 coaches. *Journal of Sports Sciences*, *31*(8), 807-819.

886 Meeûs, M. S. P., Serpa, S., & De Cuyper, B. (2010). The effects of video feedback on coaches behaviour

887 and the coach-athlete relationship. *Journal of Clinical Sport Psychology, 4*(4), 323-340.

888 Miller, A., Harvey, S., Morley, D., Nemes, R., Janes, M., & Eather, N. (2017). Exposing athletes to

889 playing form activity: Outcomes of a randomised control trial among community netball teams

890 using a game-centred approach. *Journal of Sports Sciences*, *35*(18), 1846-1857.

891 Nédélec, M., McCall, A., Carling, C., Legall, F., Berthoin, S., & Dupont, G. (2012). Recovery in soccer.

892 *Sports Medicine*, 42(12), 997-1015.

893 Nelson, L., Cushion, C. & Potrac, P., (2013). Enhancing the provision of coach education: The

894 recommendations of UK coaching practitioners. *Physical Education and Sport Pedagogy,*

895 *18*(2), 204-218.

896 Nosek, P., Brownlee, T. E., Drust, B., & Andrew, M. (2021). Feedback of GPS training data within

897 professional English soccer: A comparison of decision making and perceptions between

898 coaches, players and performance staff. *Science and Medicine in Football, 5*(1), 35-47.

899   O'Connor, D., Larkin, P., & Williams, A. M. (2017). What learning environments help improve

900   decision-making? *Physical Education and Sport Pedagogy*, *22*(6), 647-660.

901   O'Connor, D., Larkin, P., & Williams, A. M. (2018). Observations of youth football training: How do

902   coaches structure training sessions for player development? *Journal of Sports Sciences*, *36*(1),

903   39-47.

904   Partington, M., & Cushion, C. (2013). An investigation of the practice activities and coaching

905   behaviours of professional top-level youth soccer coaches. *Scandinavian Journal of Medicine*

906   *& Science in Sports*, *23*(3), 374-382.

907   Partington, M., Cushion, C., & Harvey, S. (2014). An investigation of the effect of athletes' age on the

908   coaching behaviours of professional top-level youth soccer coaches. *Journal of Sports Sciences*,

909   *32*(5), 403–414.

910   Patton, M. Q. (1990). *Qualitative Evaluation and Research Methods*. London, UK: SAGE Publications.

911   Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods*. London, UK: SAGE Publications.

912   Patton, M. Q. (2014). *Qualitative Research & Evaluation Methods: Integrating Theory into Practice.*

913   London, UK: SAGE Publications.

914   Potrac, P., Brewer, C., Jones, R., Armour, K. & Hoff, J. (2000). Toward an holistic understanding of

915   the coaching process. *Quest*, *52*, 186-199.

916   Potrac, P., Jones, R. & Armour, K. (2002). ''It's all about getting respect'': The coaching behaviours

917   of an expert English soccer coach. *Sport Education and Society*, *7*, 183-202.

918   Raya-Castellano, P. E., Reeves, M. J., Littlewood, M., & McRobert, A. P. (2020). An exploratory

919   investigation of junior-elite football coaches´ behaviours during video-based feedback

920   sessions. *International Journal of Performance Analysis in Sport*, *20*(4), 729-746.

921   Salmoni, A. W., Schmidt, R. A., & Walter, C. B. (1984). Knowledge of results and motor learning: a

922   review and critical reappraisal. *Psychological Bulletin*, 95(3), 355-386.

923   Shea, C. H., & Kohl, R. M. (1991). Composition of practice: Influence on the retention of motor skills.

924   *Research Quarterly for Exercise and Sport, 62(2),* 187-195.

925   Silverman, D., 2001. *Interpreting qualitative data: Methods for analyzing talk, text and interaction.*

926   London, UK: Sage publications.

927 Sparkes, C. (1998). Validity in qualitative enquiry and the problem of criteria: Implications for sport

928 psychology. *The Sport Psychologist, 12,* 363–386.

929 Sports Coach, U. K. (2011). *Sports Coaching in the UK 111; A statistical analysis of coaches and*

930 *coaching in the UK.* Leeds, UK: Sports Coach UK.

931 Stoszkowski, J., & Collins, D. (2016). Sources, topics and use of knowledge by coaches. *Journal of*

932 *Sports Sciences*, *34*(9), 794-802.

933 Vincent, W. J., & Weir, J. P. (2012). *Statistics in kinesiology.* Champaign, IL: Human Kinetics.

934 Williams, A. M., & Reilly, T. (2000). Talent identification and development in soccer. *Journal of Sports*

935 *Sciences*, *18*(9), 657-667.

936 Williams, A. M., & Hodges, N. J. (2005). Practice, instruction and skill acquisition in soccer:

937 Challenging tradition. *Journal of Sports Sciences*, *23*(6), 637-650.

938 Williams, A. M., & Ford, P. R. (2013). 'Game intelligence': Anticipation and decision making. In A.

939 M. Williams (Ed.), *Science and Soccer, Developing Elite Performers* (pp. 117-133). London,

940 UK: Routledge.

941 Williams, S. J., & Kendall, L. (2007). Perceptions of elite coaches and sports scientists of the research

942 needs for elite coaching practice. *Journal of Sports Sciences*, *25*(14), 1577-1586.

943 Young, B. W., Jemczyk, K., Brophy, K., & Côté, J. (2009). Discriminating skilled coaching groups:

944 Quantitative examination of developmental experiences and activities. *International Journal of*

945 *Sports Science & Coaching, 4*(3), 397-414.

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Table 1. Categories and definitions of soccer practice activities for Experiment A (adapted from Ford et al., 2010).

Drill-Based Activities	
Categories	**Definition**
Fitness	Improving fitness aspects of the game with no focus on technical or tactical skill (e.g., warm-up; cool-down; conditioning).
Technical	Isolated technical skills unopposed either alone or in a group.
Skills	Isolated technical or tactical skills from game situations, in a small group with some opposition.
Games-Based Activities	
Categories	**Definition**
Small-Sided Game	Match-play with reduced pitch size, two equal goals and reduced number of players, although can be unequal to the amount of two extra players on one side).
Phase of Play	Uni-directional match play towards one goal.
Conditioned Small-Sided Game	As small-sided games, but with variations to rules, goals, or areas of play (e.g., teams scoring by dribbling across end-line, players playing for both teams in possession, zones etc.).
Possession Games	Games with no goals in which the main intention is for one team to maintain possession of the ball from another.
Transition	
Categories	**Definition**
Transition	Movement from one activity to another or activity that is not soccer-related (e.g., drinks breaks). This includes the coach's explanation of the forthcoming activity and debrief of preceding activity.

Table 2. Interview A1: Categories, subcategories and example quotes outlining the reasons for using (a) drill-based and (b) games-based activities pre-workshop in Experiment A.

	(a) Reasons for Using Drill-Based Activities	
Categories	**Subcategories**	**Example Quotes**
(1) Develop Technical Skills	*Proactive*	"Basically, getting them as many touches as they can. Like to get them over at least a 1,000 touches in a session if not more. So just getting every boy a ball, running with the ball, dribbling, lots of touches as you can see. And getting the heads up." (C2)
	Reactive	"We've struggled in games keeping possession. So it's a build up from the game, we need to pass the ball better… We need to learn to pass the ball better and it's better unopposed than putting someone in there oppose." (C6)
(2) Warm-Up	*Preparation*	"Just a warm-up… and lots of touches on the ball. So just that they come really, really comfortable with the ball at their feet." (C1)
		"It's just a warm-up… to get the heart rate up." (C4)
	Developing Fundamental Movement Skills	"This is just fundamental movements… to get them warmed up… just to get them going." (C6)
(3) Progression		"So yeah just basically to get comfortable with the ball come at their feet being pressured….. It's relatively passive it's just to get them used to... being opposed basically." (C1)
(4) Player Enjoyment		"It's more or less little bit fun for them." (C6)
	(b) Reasons for Using Games-Based Activities	
Categories	**Subcategories**	**Example Quotes**

(1) Developing Tactical Knowledge		"…something we've seen maybe they needed a little bit of work on, or to be honest, not just from the Sunday it would be a reoccurring sort of thing, 2/3 weeks where we thought, alright we need to sort of bit do a session on that." (C3)
(2) Developing Technical Skills	*Progression of Skill*	"Bring up the skill… into the small sided game..." (C2)
	Proactive	"It's mainly for the movement, the passing and the movement amongst… them." (C3)
(3) Developing Decision-Making		"Obviously looking at their awareness on the ball, first touch, their decision making, the movements off the ball in terms of trying to support the man on the ball." (C7)
(4) Coach Development		"I think this was my B license sort of mark assessment. So that's why I kind of had to do some work on that." (C3)
(5) Measure Learning		"So, this is something we always do at the end of the session to see whether they can do things we've been trying to do within the session, in free play at the end…. Like a reward if they work well, if they work well in the session, the boys want to play, they want to play football and one of the best ways to learn is by playing football as well isn't it? Or that is sort of the way we sort and try and look at it." (C7)

Table 3. Interview A1: The frequency (percentage) and example quotes of coaches sources for using drill-based (Drill) and games-based (Games) activities

pre-workshop in Experiment A.

Sources	Frequency (%)		Example Quotes
	Drill	**Games**	
Other Coaches	7 (37%)	4 (20%)	"Again, just from coaching manuals or from any courses that I've been on. I think that particular one was from a course I've been on." (C1)
			"…probably men's football, my own football when I was a kid, done the same thing. Just getting warm." (C2)
Created on Own	3 (16%)	3 (15%)	"But it is all sort of based on triangles, sort of drills from Ajax and Barcelona and stuff like that but generally it is sort of something I come up with myself." (C3)
Coach Education Course	1 (5%)	8 (40%)	"Yeah again level 1, level 2 a good experience from now…" (C2)
			"Probably from the courses, you see a lot of them on the.. I think the youth module courses, I think that's where I picked this one in particular up." (C3)
Coaching Books	1 (5%)	1 (5%)	"I think it's in the future game, the FA future game." (C4)
			"That's probably out of a book. I probably read it in a book and just jogged it down and tried it and then on yeah. I like that." (C6)
Created on Own and Internet	1 (5%)		"...actually, I saw this at the head of the youth academy's session. I think he put it on the session planner that we got. I just adapted it from there really." (C7)
Created on Own and Coaching Books		1 (5%)	"...again, probably through manuals… things like that or it could have been a variation I've seen and adapted myself." (C1)
Other Coach and Created on Own	2 (11%)	1 (5%)	"So, we just taken our bits from it and you know, copied it identically or we modified them and sort of made our own changes to them so…" (C1)

Not Sure	4 (21%)	2 (10%)	"I don't know, it has always been my sort of preference to do this type of work." (C3)

Table 4. Interview A2: Categories, subcategories and example quotes outlining the reasons for (a) increasing, or (b) maintaining the %Time spent using games-

based activities post-workshop in Experiment A.

	(a) Reasons for Increasing the Percentage Use of Games-Based Activities	
Categories	**Subcategories**	**Example Quotes**
(1) CPD Workshop		"Obviously from the CPD, the guy who went through it told us rather than breaking it down and doing one-on-one and bring it down to it rawest form, you're better doing those sorts of situations in game time." (C1)
		"I thought that was what they wanted us to do. My impression is that they wanted more games-based activities than drill-based activities. So, we altered our training." (C3)
		"Just after the CPD, you know, it put me in a different mind-set of maybe, you know, it's, it's how you perceive." (C5)
		"What … told me, you know, I am not that blind to that, you know, to say 'my way is the best way', you know, I am open to ideas and I think that's what you've got to be, you've got to be adaptive as a coach to say, you know, I've looked through my sessions and it kind of moulded into a different way." (C5)
(2) Player Enjoyment		"Obviously the increased playing time the kids seem to enjoy it a lot more." (C1)
		"So, we give them more games-based activities or phases of play, small-sided games and most of it, the kids enjoyed it to be honest. They enjoyed it, they seemed to enjoy it more." (C2)
(3) Player Motivation		"When you do sort of technical drills based with youngsters, they know they are not being challenged. So, they'll at a certain percentage, they only put so much effort in but when you add even just one defender, they know they have got to be a bit more switched on." (C3)
(4) Player Development	*General*	"Well, we took it into games, we had a few games and the phases of play certainly, have definitely worked. You could see it coming off and it's good when it does come off, especially at that age group. So, it is working, seems to be working a lot more." (C2)
	Decision-Making	"A lot more thinking and decisions for the lads to make." (C7)

"You're putting them into match situations, and they use them techniques that come with the decision making that they'll take onto the game on the weekend." (C7)

(b) Reasons for Maintaining the Percentage Use of Games-Based Activities

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Categories	Subcategories	Example Quotes
(1) Develop Technical Skills		"…I think you definitely need the sort of, the more breakdown, slower technical stuff like passing drills you definitely need them…" (C7)

Table 5. Interview A3: Categories, subcategories and example quotes outlining the reasons for (a) decreasing, or (b) maintaining the %Time spent using games-based activities delayed-workshop in Experiment A.

	(a) Reasons for Decreasing the Percentage Use of Games-Based Activities	
Categories	**Subcategories**	**Example Quotes**
(1) Conflicting Information		"…and in the meantime, we've had the FA in haven't we and a CPD day with them. And they've given us sort of a more mixed view. That's the way I've taken it anyway. It's difficult to know which to take and I've tried to take a bit of both as I'm obviously still trying to progress myself." (C1)
		"For me personally, I have been on a couple of courses, coaching courses, and they just make you look at the game differently. Totally different. So that's one of the main reasons I think." (C2)
(2) Club Constraints	*Session Time*	"Well, we only have an hour. So, it doesn't help but that's what we've got, and we just have to get on with it. But we would like more time with them." (C2)
	Curriculum	"The method of the training this season is different to last season. Last season us as coaches decided what we were doing. This year we're following a path of what to coach. So, we're being given different things to train this year and told different things, whereas last year it was our own thing." (C3)
		"I just feel that the structure we've been given this year under the EPPP, where we've got to do… Yeah, I don't think we do enough playing drills but if the topic we're doing is say, heading, it's hard to bring that into games-based activities." (C5)
		"Possibly, just because we've got more of a structure. In particular what we've got to coach." (C7)
(3) Progression		"Yeah, we need to progress it and then, obviously, sometimes we get stuck in at the end." (C5)
	(a) Reasons for Maintaining the Percentage Use of Games-Based Activities	
Categories	**Subcategories**	**Example Quotes**
(1) CPD Workshop		"Probably, after the CPD just working to the same format that we told at the CPD last year." (C6)

(2) Club Curriculum	"With the curriculum we've been given, for the learning for the boys, probably the topics might engage more game time than the other stuff." (C6)
(3) Player Development	"I think the children learn more from it. They learn a lot more, rather than doing a training drill, if you have a little game. If its game related, they take a lot more from it." (C4)
	"So that you learn it within the game, not me and you running to each other and then when I get a touch I run to the other kid." (C6)

Table 6. Categories and definitions of soccer practice activities for Experiment B (adapted from Low et al., 2013).

Non-Active Decision-making

Activity in which the main action execution decision/s for the player in possession of the ball has only one degree of freedom option that is usually pre-determined by the coach.

Categories	Definition
Drill Without Active Decision-Making	Activity either alone with a ball or in a small group involving no opposition or somewhat passive opposition so that the main action execution decision/s for the player/s in possession of the ball has only one degree of freedom or option *that is usually pre-determined by the coach*. Also, at least the majority of time for that drill meet this definition.

Active Decision-making

Activity in which the main action execution decision/s for the player in possession has at least two or more degrees of freedom or options, mostly involving moving opposition.

Categories	Definition
Small-Sided Game	Match-play with match-like goals, but reduced pitch size and reduced numbers of players, usually equal amounts of players, although can include players who play for whichever team is in possession.
Conditioned Small-Sided Game	As small-sided games, but with variations to rules, goals, or areas of play (e.g. teams scoring by dribbling across end-line or into zones).
Possession Games	Games with no goals in which the main intention is for one team to maintain possession of the ball from another.
Uni-Directional Games	As conditioned and/or small-sided games, but possession moves mainly in one direction only and player numbers are 2 vs. 1, 3 vs. 1, 3 vs. 2, or 4 vs. 2.
Phase of Play	Match-play but possession moves mainly in one direction towards one goal with at least three defenders involved.

	Transition
Categories	**Definition**
Transition	Movement from one activity to another or activity that is not soccer-related (e.g., drinks breaks). This includes the coach's explanation of the forthcoming activity and debrief of preceding activity.

Table 7. Interview B1: Categories, subcategories and example quotes outlining the reasons for using activities with non-active decision-making pre-workshop in Experiment B.

Categories	Subcategories	Example Quotes
(1) Develop Technical Skills		"Because I find it good for doing unopposed turning on the ball. I think it's a good little technique for how many numbers we had there as well. Its keeps them all repetitive. As you see within five seconds all the players have has go, they're running around. Not waiting long are they." (C3)
		"Yeah it's as technique. They're not checking their shoulder so we're getting them to receive side on." (C5)
(2) Warm-Up	*Preparation*	"Yeah, I don't want everyone sitting around waiting. I've got my set up, so I don't want to let them have a game because I don't want to destroy my set up. So, I'm thinking ball each, go practice your keep ups. It's a simple thing until everyone or most of the group turn up." (C4)
		"That's just the warm-up, to get them going with the ball. They're meant to get five balls going. So, you end up playing it in and then going round the other side, if it's the same one. Yeah it is." (C6)
	Developing Fundamental Movement Skills	"It's just a server and a player. Then go and get the ball off the next one to get them moving. There's all different fundamental movements and dynamic stretches as they're moving round. Probably start of the session that." (C4)
(3) Progression		"This was a progression yeah of teaching different types of heading." (C5)
		"To run with the ball, it would be to get out and then that, yeah, again is part of building up the session to get into switching play or whatever the topic may be." (C6)
(4) Player Enjoyment		"Yeah, enjoyment in what I class as a quite a dull session. Just ball heading. So trying to bring some fun really into that dull training session. I'm a big believer that if they're enjoying it they're learning. And I do believe they improved their heading from it." (C5)
(5) Repetition		"So, they keep going round, everyone is changing, getting a go. Yeah so repetition and then just starting basic so we can move it up." (C1)

| **(6) Maximise Participation** | "That was a good way for the size of the group that we have got so we could have different groups working at a time. So, maximising the amount of time players have on the ball." (C7) |

Table 8. Interview B1: The frequency (percentage) of coaches sources for using activities with non-active decision-making pre-workshop in Experiment B.

Sources	Frequency (%)	Example Quotes
Other Coaches	2 (10%)	"I think it was [another coach] who had done that. A session quite similar to this with the youth team when I was at [another club] a couple of years ago." (C7)
Created on Own	7 (33%)	"…specifically, that one. I probably just made it up myself." (C1)
		"Probably made it up. Adapted it, made it up." (C6)
		"It's a simple thing that I've done when I was younger. I mean I played a little bit, and if I was waiting for session to start I'd practice my keep ups." (C4)
Coach Education Course	5 (24%)	"I think this one was from a course, from when I did my module one course. That's probably where I took it from." (C2)
Coaching Books	1 (5%)	"I probably got that out of a book. Or you know the FA when they send you those magazines, I've probably seen that in there." (C6)
Internet	1 (5%)	"Again, this was another on that I thought of and picked up off the internet in a smaller version and I tried it in a bigger one." (C5)
Not Sure	5 (24%)	"… that's probably years old that. I don't know. It is just to get them moving around." (C6)

Table 9. Interview B2: Categories and example quotes outlining the reasons for increasing the %Time spent using activities with active decision-making post-workshop in Experiment B.

Categories	Example Quotes
(1) The CPD Workshop	"It was just [researcher's] train of thought. It wasn't anything we hadn't already done it was just tweaking what we were doing. I still think the decisions were in there, but it was really pulling out them decisions." (C5) "It was just seeing how much, obviously the ideal thing we want to do is have the kids making as many decisions as possible. So, we took that on board and tried to put it into all the sessions, whether it be the warmup, whether it be the cool down at the end or the main chunk of the session. Just trying to make sure the kids have as many decisions to make as possible." (C7)
(2) Develop Decision-Making	"Where's the decision? I'm massive on the decisions in matches. And that made me think about it as well. I'm massive about decision making in games but in training I'm not looking at it much. You know because you get lost in technical, tactical you know. Whereas now I'm looking at bringing the decision making into the training as well." (C5)
(3) Easy to Implement	"It's not rocket science to add it in it's just tweaking what we were already doing." (C5)
(4) Facilities	"It's probably gone into more of a game format because we've got half a pitch at (new venue)." (C6)

Table 10. Interview B2: Categories and example quotes outlining the coaches' perceptions of the purpose of the workshop in Experiment B.

Categories	Example Quotes
(1) Increase Decision-Making	"Well, not necessarily the topic but what games they're doing, what sort of decisions the boys are having to make, individually, decisions they've had to make as a team. Little bits like that. So that's worked quite well". (C7)
	"This season's CPD? It was about your decision making. You know last year was drill- and games-based activities so this year was your decision making and the active decision making the in the session." (C5)
(2) Increase Match Realism	"To get it more realistic, the training sessions have more game realism than just standing on a cone. I was never a believer in that to be honest before. I never saw the point of that. I always wanted it more game based, more end zone games where you can make it more realistic." (C4)
	"Make them more game related. Within the game, there are decisions to be made there so they're making their own minds up. As you say, doing lines of repetition you tell them what's going to happen before they get there so there's no thought gone into that. Whereas in a game, small sided, they're going to have repetition by having loads of touches and those decisions within the game are going to be more realistic all over the pitch rather than in straight lines." (C1)
(3) Increase Opposition	"To cut down the time they're playing unopposed. Instead of just passing drills where they are all looking nice and cosy and comfy, making it opposed all the time. Even if it is just 3 v 1, or 6 v 6, or 4 v 4." (C6)
	"So, it's not sort of boring or unopposed all the time." (C3)
(4) Maximise Participation	"If they're not doing stuff, they'll get bored. Which is what we've just talked about. So, it's keeping them involved right through the session from start to go and then they want to come back next week, which is what it's all about." (C2)
(5) Coach Development	"To help us as a coach. Obviously if we didn't have this then we wouldn't be moving forward." (C2)
(6) Provide Feedback	"Just to highlight what the sessions are looking like." (C7)

Table 11. Categories and example quotes outlining the coaches' preferences for <u>the CPD workshop delivery style of the intervention.</u>

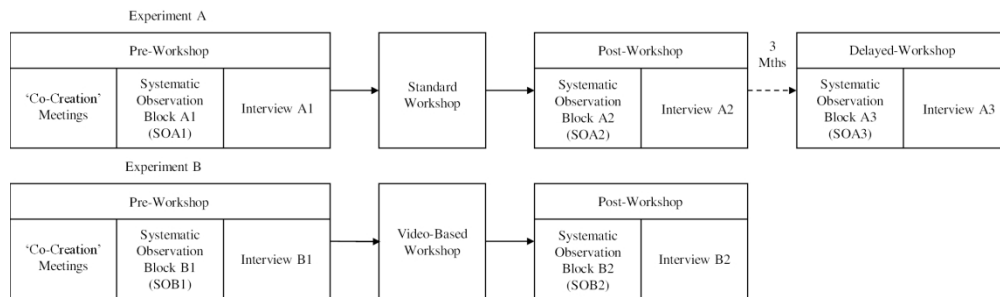| **Preference to the interactive video-based workshop in Experiment B**	
Categories	**Example Quotes**
(1) Use of Video	"Yeah if someone said to me '[coach], that warm up you done you could have added this' I wouldn't have got it really but where I'd seen it. I thought wow, and that's what twigged for me. We already do that, let's just add that. And that's what we did, yeah." (C5)
(2) Discussion	"I like the discussion. Everyone has an opinion and not everyone's opinion is the same, I think that's why football is great. You know someone might have a different opinion about football to me but that's why we all love football. I like that. I prefer the discussion type." (C4)
(3) Better Learning Opportunity	"Yeah, and I think it stays there more when you do that. If someone is telling you it can go over your head and you switch off." (C5)
(4) Tailored Audience	"I thought it worked better where it was more personal. It was more personal to the actual group itself. Like you might have a few people switching off if it's not their group. But I thought it worked better like that, actually seeing some of the sessions." (C7)
No Preference to either workshop	
Categories	**Example Quote**
(1) Developing Coaching Practice	"Oh no, they were both really good, obviously." (C2)

Figure 1. Timeline depicting the experimental design and procedure of Experiment A and B.
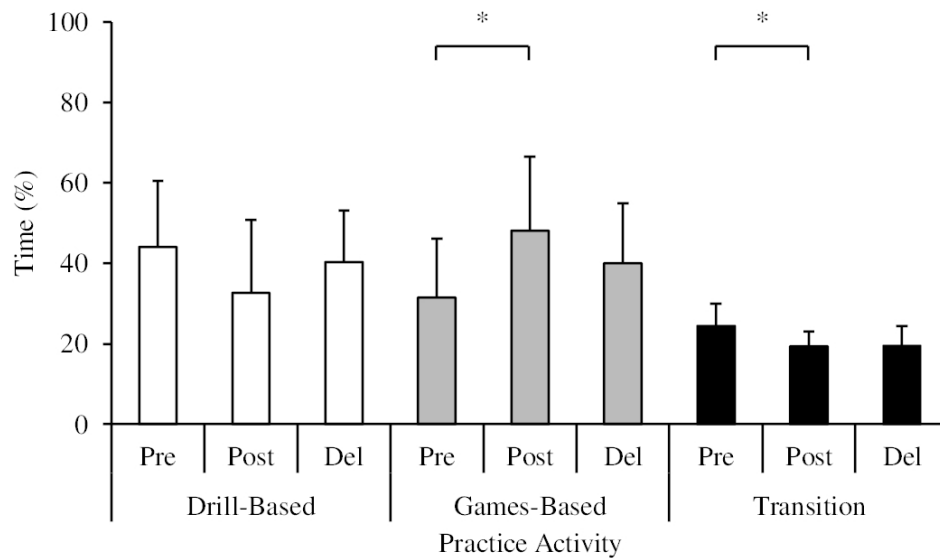
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Figure 2. Mean (standard deviation) %Time spent using drill-based activities (white bars), games-based activities (dark-grey bars) and transition (black bars) activities presented as a function of activity and phase. * denotes significance p < 0.05.
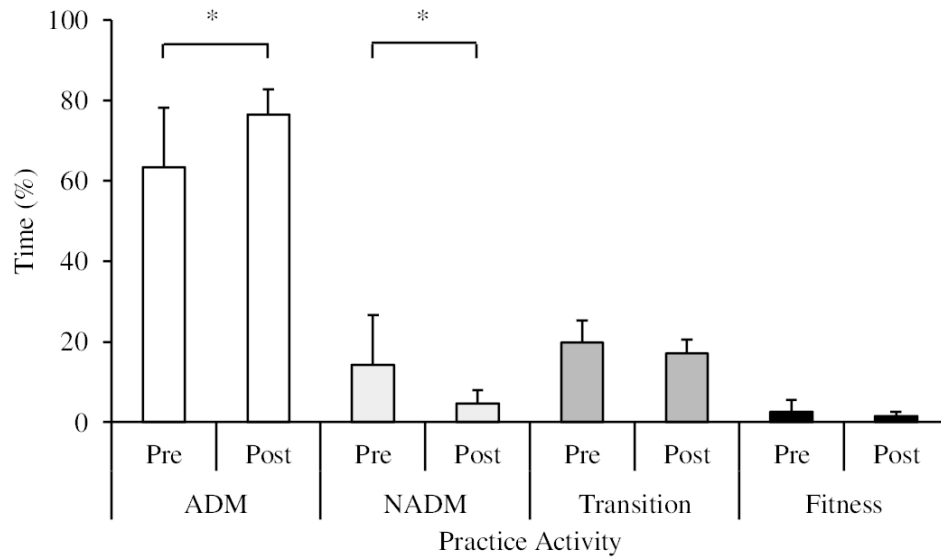
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Figure 3. Mean (standard deviation) %Time spent using using activities with active decision-making (white bars), non-active decision-making (light-grey bars), transition (dark-grey bars) and fitness (black bars) presented as a function of activity and phase. * denotes significance p < 0.05.

140x83mm (200 x 200 DPI)