



Article

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How do high-level youth soccer players approach and solve game problems? The role of
strategic understanding

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Abstract

Background: Invasion team sports such as soccer require teams and individual players to understand the game and problem solve. One aspect of problem solving that has recently been more prominent in team sport literature is the role of metacognition.

Purpose: The purpose of the current study was to examine how high-level youth soccer players approach and solve problems, with a particular focus on the role of strategic understanding. We were interested in the range and sophistication of cognitive strategy and process used by players when tackling game problems. Also, the ways in which they plan, monitor and evaluate how they approach and solve problems.

Methods: Eighteen high-level youth soccer players took part in semi-structured interviews which adopted Applied Cognitive Task Analysis (ACTA) protocol. Interview data were analysed using deductive content analysis to distinguish use of cognitive and metacognitive thinking.

Findings: Results showed that players displayed a range of cognitive processes when solving problems, but more sophisticated processes were least employed. Furthermore, there was little evidence of a strategic approach to problem solving.

Conclusions: Players would benefit from practicing their problem-solving skills. Coaches should pay due attention to ‘what’ and ‘how’ players think when problem solving. Coach education might consider how to educate coaches to better equip players to solve stubborn game problems. One possibility is to present coaches with methods which make player thinking overt.

Keywords: coaching; cognition; metacognition; team sport; thinking

74 2009, 2011; Johnstone and Morrison, 2016). This suggests that skilled performers are both
75 quicker and more efficient at accessing knowledge about the game to inform how to execute
76 their next action. Most recently, investigation of the visual search strategies of skilled
77 performers has shown them more able to effectively prioritise and locate important information
78 to inform their decisions (Roca, Ford, and Memmert 2020). Consequently, the visual search
79 strategies of skilled performers provide greater opportunity to anticipate and act effectively
80 when under strong time constraints, such as during unique game situations (Collins, Collins,
81 and Carson 2021). A recognition primed decision-making approach to training (RPDM; Klein,
82 2008) where visual stimuli are repeatedly presented, has therefore been proposed to enhance
83 the development of anticipation skills. For example, Lex et al. (2015) found that experienced
84 soccer players possess a more structured memory of team tactics and require less time and
85 information to locate suitable options.

86 Parallel strands of research have examined the role of metacognition. Metacognitive
87 thinking has been defined by Flavell (1979) as thinking about one's thinking and in a sporting
88 context, metacognition has been broadly described as cognition about thoughts and feelings
89 (MacIntyre et al. 2014). Seminal work on this topic has referred to metacognition as involving
90 problem solving skills such as predicting, checking, monitoring, testing and controlling
91 deliberate attempts to learn (Brown, 1987). Importantly, empirical evidence indicates that
92 metacognition can be taught in the school classroom, with children as young as eight years old
93 capable of developing (Jacobs and Paris, 1987; Veenman and Spanns, 2005; Wang et al. 2021;
94 Weil et al. 2013). Indeed, further empirical research suggests children younger than eight years
95 old have the capability to think on a meta-level (Pino-Pasternak and Whitebread, 2010).
96 Evidence pertaining to the metacognitive capabilities of children is important for coaches to
97 recognise, suggesting that age is no reason to disregard the role of metacognition when problem
98 solving in team sport. Nonetheless, how information is processed and the ways in which

99 declarative and procedural knowledge structures interact during the problem-solving process
100 is complex and remains unclear.

101 ***The relationship between problem solving and decision making***

102 Making decisions is a part of problem solving and in dynamic team sports such as
103 soccer, there is almost never a moment when players are not required to make decisions about
104 a problem to be solved. To date, a range of existing literature has focussed on decision making
105 in team sport and its associated elements, such as perception, attention and anticipation
106 (Vaeyens et al. 2011; Roca, Williams, and Ford 2012; Roca, Ford and Memmert 2018). In
107 comparison, however, minimal attention has been paid to the problem-solving process and how
108 this works in combination with decision making. For example, the selection of an appropriate
109 action in invasion team sport has been assessed in time pressured situations (Kinrade, Jackson,
110 and Ashford 2015), as has the ‘thinking through’ of contextual information during the decision-
111 making process and its impact on how and why players and teams might change their plan of
112 action (Maquet and Kragba, 2015). Importantly, however, it seems safe to suggest that even
113 expert players will not solve every problem first time (especially when playing against other
114 expert players). This is where further research is required to establish the mechanisms of player
115 thinking as a problem becomes more stubborn, or otherwise, when the difficulty of a problem
116 increases. Notwithstanding these exceptions, coaches are left with a void of information about
117 this critical aspect of team games, an important omission which deserves attention.

118 ***Cognitive process and strategy used for problem solving***

119 In the context of soccer, Price et al. (2020) built upon Weinstein and Van Mater Stone’s
120 (1993) framework for knowledge sources in an attempt to measure and apprehend the extent
121 to which players think strategically when problem solving. In this framework, the player is
122 required to understand several interacting factors;

- 123 • Themselves (i.e., how do I learn best, what motivates me, what are my individual action
124 capabilities)
- 125 • Players involved (i.e., individual and collective action capabilities, preferred team
126 playing style)
- 127 • Problem (e.g., the opponent is creating goal scoring chances by playing through our
128 midfield area)
- 129 • Goal (e.g., we aim to compact the central areas to deny the opposition playing through
130 our midfield)
- 131 • Solution (e.g., our forwards will position themselves more narrowly when possession
132 is lost).

133 Factors are combined through a cognitive strategy to monitor whether progress is being
134 made toward solving the problem. Cognitive strategy suggests the player is actively selecting,
135 executing, monitoring and controlling a cognitive process (e.g., I will *copy* the positioning of
136 my teammate when we lose possession, until I feel confident to position myself).

137 Thinking on this meta-level therefore involves an ongoing learning process of planning,
138 monitoring and evaluating how to solve the problem. Players who think metacognitively will
139 continue this ongoing learning process until the problem is no longer a problem, or another
140 problem takes priority (usually because of the level of severity the problem causes if left
141 unsolved). Consequently, the purpose of the current study was to examine how high-level
142 youth soccer players approach and solve problems, with a particular focus on the role of
143 strategic understanding. Our primary objective was to establish the range and sophistication of
144 cognitive strategy and process used by players when tackling game problems. We also wished
145 to examine the ways in which players are in control of how they plan, monitor and evaluate
146 how they approach and solve problems. Specifically, how they use knowledge of the game,

147 knowledge of people playing the game (including themselves), and knowledge of cognitive
148 strategies.

149 **Materials and Methods**

150 *Participants*

151 Participants in the current study ($N=18$) were Under 13 and Under 14 players from one
152 professional boy's youth football academy in England. Players train three times and play one
153 game per week against opposition boy's youth academy teams. All players were coached by
154 UEFA (Union of European Football Associations) qualified coaches and have been coaching
155 professional boy's youth academy football for at least five years. The heads of coaching at
156 several professional boy's youth football academies in England were initially contacted to
157 gauge their interest in taking part. One academy was selected based upon the head of
158 coaching's belief in the research project aims. All players within the Under 13 and Under 14
159 teams were invited by the club via email to take part in the study (excluding goalkeepers due
160 to their unique role in the team), and 85% accepted this invitation.

161 All 18 participants were male and reported themselves to be British. Prior to gaining
162 informed consent from all participants and their parents/guardians, a University ethics
163 committee approved the study, and participants and their parents/guardians were notified that
164 they could withdraw from the study at any time.

165 *Procedures for Interviews*

166 All interviews took place as a one-to-one conversation between the player and first
167 author in the club's classroom. Each interview started with a general introduction and rapport
168 building conversation, whereby the purpose of the study was explained to players, as well as
169 their rights and a declaration of confidentiality (White and Thomson, 1995). Discussion was
170 guided with supporting probes from Militello and Hutton's (1998) Applied Cognitive Task

171 Analysis (ACTA) ‘toolkit’ which involved both retrospective and prospective probes (see
172 Table 1). The protocol followed in each interview is detailed below:

173 1. **Task scenario.** All participants responded individually to the same exemplar football
174 scenario (playing out from the goalkeeper), as this scenario reflected a moment of the
175 game that was consistent within the club’s coaching curriculum.

176 2. **Knowledge audit.** Each responded individually to a video clip from their most recent
177 competition game. To minimise memory distortion, there was a maximum time period
178 of two days between the competition game and the interview. Each clip was no longer
179 than 30 seconds in duration and was selected by the Under 13 and Under 14 team
180 coaches on the basis that the player being interviewed had clearly and obviously
181 outwitted an opponent. Therefore, the player was deemed to have either solved a
182 problem or made some progress in solving a problem. To confirm reliability of selected
183 clips, the first author requested a rationale from the coaches to explain their choice of
184 clips, and all clips were checked by the first author against the rationale. If the first
185 author disagreed with a choice of clip, the coaching team provided an alternative.

186 3. **Simulation.** Participants responded individually to a video clip selected by the coach
187 (again no longer than 30 seconds in duration) from the club’s senior adult team during
188 season 19/20. In the clip, a player had been clearly and obviously outwitted by an
189 opponent. Therefore, the player had failed to solve a problem, or made weak or no
190 progress in solving a problem. All participants did not respond to exactly the same
191 stimuli, as the clips were determined by their own individual playing position, although
192 the Under 13 and Under 14 team coaches were asked to select clips showing problems
193 of equivalent complexity. To confirm reliability of the stimulus provided by the clips,
194 processes used in the knowledge audit were repeated in the simulation, providing an
195 internal point of comparison.

196 Following preliminaries, interviews lasted an average of 22 minutes (range = 18–32 minutes).
197 All verbal responses were audio recorded using a Voice Memos mobile application
198 (<https://support.apple.com/en-gb/HT206775>) on an Apple iPhone XS then transcribed
199 verbatim. All visual responses were screen recorded using Tactical Pad
200 (<https://www.tacticalpad.com/new/>), an interactive football technology application used on an
201 Apple iPad (7th Generation) device.

202 *Data Analysis*

203 To move the concept of problem solving and strategic understanding toward a more
204 specific, situational and context rich outlook (Elo and Kyngas, 2008), data were analysed
205 deductively. To guide this process, Weinstein and Mayer's (1986) structured categorisation
206 matrix of learning strategies was used to organize the data (see Table 2). Specifically, the
207 deductive analysis was used to assess the extent to which views gained supported elements of
208 understanding (cognition) and deep understanding (metacognition). In listing appropriate data
209 extracts for each category in the matrix, the first author asked themselves questions such as;

- 210 1. To what extent is rehearsal, organisation and elaboration at play?
- 211 2. To what extent is person knowledge, task knowledge and strategy knowledge at
212 play?
- 213 3. How do cognitive processes interact?
- 214 4. How do metacognitive processes interact?
- 215 5. How do cognitive processes interact with metacognitive processes?
- 216 6. Where do any of these processes fail to interact?
- 217 7. What is suggestive of the players' confidence in his responses?

218 During the analysis process, some parts of the data deemed to be worthy of a higher
219 level of consideration (Patton, 1990) were also considered at a more latent level (Bengtsson,
220 2016). As we were interested in uncovering underlying cognitive and metacognitive processes

221 and strategies used, interpretation was at times needed in order to discover the deeper meanings
222 of some words and phrases individuals used (cf. Bengtsson, 2016; Javadi and Zarea, 2016).
223 For example, a common term used by all players in this study which was worthy of discovering
224 a deeper meaning was ‘checking my shoulder’. Every time this phrase appeared in data analysis
225 categories from the matrix it was considered as a meaning unit. All meaning units were
226 extracted as quotations and were read and re-read by the first author. Interpretation of meaning
227 units was in context to the sentence to which it appeared, the interview protocol (task scenario,
228 knowledge audit, simulation) and the global language of soccer. In this example, ‘checking my
229 shoulder’ is widely understood in soccer as scanning. Scanning is “an active head movement
230 where a player’s face is temporarily directed away from the ball to gather information in
231 preparation for subsequently engaging with the ball” (Gordet, et al. 2020).

232 Interpreting when and how players were thinking cognitively and metacognitively
233 required the first author to be immersed in the data. In doing so, data extracts for each higher
234 order category (strategy) were continually compared and contrasted, then narrowed down into
235 representative lower order subcategories (processes). Narrowing of data required a clear
236 description of subcategories (processes), which is provided in Table 2. The process of
237 narrowing data required the first author to group extracts into subcategories, which initially
238 caused some extracts to overlap into multiple subcategories. By looking for similarities and
239 differences in the meanings between data extracts, the first author was able to reduce
240 overlapping and ensure all data extracts were placed in singular subcategories.

241 To enhance trustworthiness, sample data extracts were examined by the second and
242 third author at regular intervals, with any issues of contention discussed until a consensus of
243 opinion was reached. The first author also discussed the process with a colleague, who was
244 knowledgeable about coaching and trained in qualitative methodology, but blind to the
245 objectives of the study (Krane et al. 1997; Wright, Trudel, and Culver 2007), on three separate

246 occasions. The purpose of having ‘critical friends’ was to encourage discourse and reflexivity
247 to allow multiple interpretations of the data to be generated (Smith and McGannon, 2017).
248 Finally, the first author made reflexive notes immediately after each interview and throughout
249 the data analysis process to enhance the transparency of the choices and interpretations made
250 (Tracy, 2010).

251 **Results**

252 In the following sections, we outline how players utilised cognitive and metacognitive
253 strategies and processes to solve game problems. Representative quotes are used to provide
254 better appreciation of the context data were collected in, with exemplar data extracts for each
255 category of learning strategy also presented in Table 2. To maintain anonymity, players are
256 referred to by a unique letter.

257 **Cognitive Strategies and Processes**

258 *Rehearsal*

259 Three cognitive processes are associated with this strategy: copying, verbatim and
260 repetition. In the first case, this was most evident in how players utilised copying as a process
261 to start their reasoning during task scenarios, especially in relation to the club’s preferred
262 playing style. For example, this typically involved the player copying the coaches’ tactical
263 reasoning, which was supported by Player X when he explained how the team’s playing style
264 was a guide for decision making:

265 We don’t normally kick it high, we normally play around the back, so we’d like pass it
266 to our centre midfielder, see if our full backs are on, if not, shuffle it back round to get
267 it over this side where the space would be free.

268 In the case of using verbatim as a cognitive process, this tended to involve reference to
269 technical or tactical language (e.g., ‘bump up,’ ‘shuffle,’ ‘triangles,’ ‘play around’), formations
270 (in this case, 1-4-3-3) and team shape (e.g., high or low, wide or narrow), all of which were

271 common to both the club's style of play and the coaching team's collective language. The use
272 of verbatim was exemplified by Player A during simulation, when he described how 'he
273 bumped up, and if he just...if he didn't bump then they would have still had the ball.'

274 Repetition was most commonly referred to during task scenarios. Examples of this
275 occurred in relation to patterns of play (e.g., goalkeeper to centre back to centre midfielder
276 when playing out from the back), as exemplified by Player F when he commented, 'yeah,
277 because we work on it a lot in training. Playing out from the back. And like switching players
278 over. We practice the same kind of patterns.'

279 *Organisation*

280 Two cognitive processes were linked to this strategy: grouping and categorizing.
281 Categorizing was the most frequent process used, commonly alongside copying. This typically
282 involved players summarising the options available in order to decide 'what next'. They would
283 then use short cuts or tactical principles to decide on the most appropriate solution (e.g., play
284 around the opponent if we cannot play through). When asked about the 'what next' when
285 playing out from the back, Player F explained how playing it back to the centre back would
286 create the opportunity to build play using the other side of the pitch, suggesting that 'if we
287 played round, he can just lock it off and then we're back forcing it that way.'

288 The process of grouping explains how a group of people are interdependent; effective
289 recognition and accommodation of this is another important aspect of metacognition. This is
290 relevant to the tactical side of the game of soccer, where one player's actions have an effect on
291 both their teammates and the opposition. However, this was the least frequent process under
292 the strategy of organisation, although, during his knowledge audit, Player A explained that 'at
293 first, I was going to carry on running, but then when I saw [teammate] and the other two
294 coming, that's why I went inside.'

295 *Elaboration*

296 During the knowledge audit, the most frequent cognitive strategy was elaboration,
297 which includes three cognitive processes: mental note taking, mental images and self-
298 questioning. The most common process was mental note taking, where a player would typically
299 aim to remember certain pieces of information about the game, or people playing the game,
300 with the intention of using that information to inform future actions. Player L provided an
301 example of how he used this process:

302 In the start of the game I was like...I just saw the player who was on me, it was just
303 like, he didn't follow the ball, he followed my body, he always like followed my body
304 in the first like five minutes.

305 With regards to the use of mental images, evidence of approaching a problem by having
306 a clear representation of their intended goal in mind occurred most frequently in the task
307 scenario and least often in the knowledge audit. Player S explained his thought process of how
308 he was seeking to gain possession of the football in his defensive third and then intended on
309 using possession once it was gained. He made reference to two mental images; the first when
310 he was out of possession, when he said how he 'just had to keep running...just don't let my
311 man run off me...try and run back as quick as I could, don't like stop', the second as he gained
312 possession, when he said, 'just keep my eyes on the ball, don't lose it.'

313 The final process linked to elaboration was self-questioning. This was mostly evident
314 during the simulation and knowledge audit, and involved the player checking and challenging
315 their own thoughts in relation to the problem faced. In most cases, this process was evident
316 when their team had the ball, and they were concerned about losing possession. One example
317 was illustrated by Player U, when he asked himself 'what if I lose it? Is someone there to like
318 give me an option or to like help me recover?' In a further example, Player X asked himself,
319 'so what am I going to do next? ...because I beat the one person, then their number eight is

320 going to start coming to press me, so then what am I going to do, like end-product, what am I
321 going to do? What am I going to do in that situation?’

322 **Metacognitive Strategies and Processes**

323 *Strategy*

324 This metacognitive strategy consisted of three processes: selection of a cognitive
325 strategy, execution of a cognitive strategy, and monitoring and control of a cognitive strategy.
326 Notably, there were few examples of a player evidencing selection of a cognitive strategy in
327 their problem-solving process. One of these examples, from Player X, involved the strategy
328 selection of elaboration (mental note taking). He said:

329 I was thinking like they...throughout the whole game they went into that centre mid
330 once, and I think it was because our team just dropped back fully. So, I thought they’re
331 going to hit it long, so I dropped off to see if they’d hit it long...we were pressing and
332 then I decided to just drop off because I was looking out, I knew they just hit it long
333 every time.

334 Importantly, at no stage during the interviews was there evidence of any player demonstrating
335 an awareness of how a cognitive process was to be executed, nor how such processes were
336 monitored and/or controlled. The implications of this for coaches and for coaching are
337 important because, should a player’s solution be tested and fail, it becomes difficult for them
338 to determine the cause for failure. For example, if the player lacks reflection on their cognition,
339 the cause of failure could be the choice *or* execution of a solution, *or* the deployment of an
340 inappropriate and poorly executed cognitive process.

341 *Person*

342 Three processes were associated with this metacognitive strategy: knowledge of self,
343 knowledge about others and knowledge of the universal. In the case of knowledge of self when
344 solving problems, players tended to make reference to their physical qualities as a means to

345 justify their intended actions. For example, Player D said, ‘I know I can use my arms to keep
346 him behind me...use strength, my strength to try and push him off the ball’, while Player B
347 suggested, ‘my first priority is to get the ball under control and use my strength...so my arms
348 and use my body to block out the defenders.’

349 Our results also show that knowledge of others would more often refer to knowledge
350 of teammates than knowledge of opponents and tended to be used alongside the cognitive
351 process of categorising. This was most evident in players’ appreciation of their teammates’
352 responsibilities when playing out from the back and how their ability to perform a role was
353 interdependent on teammates’ capabilities. This was evidenced by Player F: ‘I think we have
354 the ability to play round. Our goalkeeper’s passing is very good, so we can play back to him
355 and then do it that way.’

356 On many occasions, players exercised their knowledge of universal beliefs as a
357 metacognitive process. One example of this was evident in the task scenario, when Player B
358 noted that a youth academy footballer should be capable of executing a certain level of skill,
359 suggesting that ‘in situations like that...it’s what you can individually do, he should...if I
360 played in academy football for this team, he should be able to get past them if it’s a one on
361 one.’

362 ***Task***

363 This metacognitive strategy was associated with two metacognitive processes:
364 understanding how to approach learning and the impact of learning on task. During the task
365 scenario, only three players evidenced an awareness of their learning approach, which in all
366 cases were related to feelings and emotions. For example, Player I recognised that he performs
367 better when he is not feeling too relaxed in possession, explaining that ‘I sort of think when
368 I’m playing out from the back, and in this instance, that I just need to relax, not overly relaxed
369 though...take it round, like not slowly but relaxed I guess.’

370 In most cases, when the impact of learning on task was evidenced, it was in conjunction
371 with knowledge of others (universal). This meant that players' thought processes were often
372 along the lines of how to make the task harder for their opponent, based upon what typically
373 increases task difficulty in soccer. This was evidenced by Player S, who said 'if it's going to
374 the line it's not going anywhere, it's not like he's cutting in the pitch and he's got the whole
375 pitch to go, he's only got that much of the pitch to go, so try and block him, instead of getting
376 a penalty, get a corner.'

377 There was just one example of a player who used impact of learning on task in relation
378 to what they knew about the specific opponent. Even in this case, however, knowledge of the
379 opponent was based only upon physical attributes. Player Z explained in the simulation, 'if
380 he's faster than me, I'd tactical foul him, but if he's like...if I'm the same pace as him, I'd try
381 and catch up to him and like force him onto the line.'

382 **Discussion**

383 The purpose of the current study was to examine how high-level youth soccer players
384 approach and solve game problems, with a particular emphasis on the role of strategic
385 understanding. The main benefit of the ACTA interview protocol we employed was to capture
386 player thinking in order to differentiate between understanding (cognition) and deep
387 understanding (metacognition).

388 ***Having a solution is not enough!***

389 To develop deeper game understanding, our findings suggest there is a need to combine
390 decision making training with explicit coaching to develop a range of cognitive processes (e.g.,
391 copying, grouping, mental note taking). In reality, however, coaching for understanding in the
392 team sport literature is dominated by decision making and not combined with problem solving.
393 Understanding team principles of play and tactics tend to be a focus for coaches (Lex et al.
394 2015; Tee, Ashford, and Piggott 2018), with little or no emphasis on how players think. For

395 example, our findings show that players most frequently solve problems by using copying,
396 grouping and categorizing. These processes typically related to soccer language, patterns of
397 play, tactical concepts and positional connections between players, to guide decisions when
398 problem solving. More sophisticated levels of thinking, such as elaborative cognitive processes
399 (e.g., mental note taking, self-questioning and mental images) were utilised less, and use of
400 analogies was not demonstrated at all from our participants.

401 Evidence of less sophisticated thinking processes is not necessarily a result of the
402 players' age or stage of cognitive development. Children younger than those in our study have
403 evidenced metacognition, albeit outside of a soccer context (Pino-Pasternak and Whitebread,
404 2010; Ricker and Richert, 2021; Veenman and Spanns, 2005; Wang et al. 2021; Weil et al.
405 2013). Instead, players seem merely to be using and demonstrating the soccer knowledge they
406 have been taught by their coaches. Indeed, based upon the evidence from our study, it is
407 unlikely the players we interviewed had been coached to learn and develop a range of cognitive
408 processes, and most certainly not elaborative processes.

409 Yet, soccer is a complex task where there is a high volume of dynamic or conflicting
410 contextual information. Players need to understand how a game context is layered with co-
411 ordinated and patterned actions of an opposition team, individual or subgroup of players
412 (Maquet and Kragba, 2015; Ashford, Abraham, and Poolton 2020). This would suggest that
413 more sophisticated cognition is required (Weinstein and Mayer, 1986; MacIntyre et al. 2014),
414 for players to outwit their opponent. We propose that players with a wider range of cognitive
415 tools are better positioned to solve game problems. In other words, players capable of using
416 elaboration (and not just rehearsal and organisation) have greater potential to outwit their
417 opponent, even when the opponent is technically or physically superior. The aim of soccer
418 (indeed any team sport) is to cause, sustain and enhance the stubbornness of a problem for the
419 opponent. For coaches, the skill of developing players' cognitive processes is not straight

420 forward and there is, therefore, no singular method to address quality of player thinking.
421 Instead, a multi-methods approach, we suggest, would provide greater opportunity and
422 possibility for players to become more aware and in control of their thought processes. Some
423 multi-methods include conversing with players on and off field about their performance and
424 learning goals, using regular reviews and debriefs, providing in time and on demand feedback,
425 watching and discussing soccer video clips, encouraging players to ask for help on specific
426 areas of performance, and encouraging players and coaches to share their thoughts and feelings.

427 *Testing and tweaking*

428 Our findings show that players seldom recall or demonstrate thoughts concerning how
429 they have planned to judge their own understanding of a solution (i.e., Did it work? How will
430 I know? If it didn't work, why not? If it did work, what does this mean for next time I am faced
431 with this problem?). If players were more proficient at learning how to deal with game
432 problems, data would evidence a strategic use of knowledge when approaching a problem. In
433 actuality, however, our findings show that player thinking is dominated by static contextual
434 information about team playing style, execution of skill, and roles and responsibilities of
435 playing positions. Players' consistent reference to static information during problem solving is
436 perhaps unsurprising, however. Research in formal coach education suggests minimal intent to
437 involve coaches in their own learning and in context specific situations (e.g., Cope et al. 2020).
438 Furthermore, coach education is largely dominated by the sport's technical and tactical content
439 knowledge, with limited integration of how players engage with learning strategies (Abrahams
440 and Collins, 2011). To clarify, if coaches are neither taught nor encouraged to learn about
441 methods to enhance the learning process of players, then it's likely that players will lack an
442 awareness of how they learn best.

443 During problem solving, judging the effectiveness of one's problem solving approach
444 suggests a player is being reflective during the learning process. However, metacognition is

445 more than simply reflecting and, importantly, involves a strategic use of knowledge as
446 problems are approached and solved. In soccer, which is based upon outwitting the opponent,
447 knowing about the people playing the game (yourself, teammates and the opponent) *should* be
448 major considerations. The current study offers limited evidence of players using their
449 knowledge of others to shape their decision making. For example, thinking metacognitively
450 about a problem to be solved requires an awareness of performance. This can include an
451 awareness of capabilities, traits, strengths and weaknesses of self and others. In the context of
452 a game, Levi and Jackson (2018) explain that performance is a dynamic ‘contextual prior’. In
453 other words, being aware of performance (and how it changes) provides the problem solver
454 with information to guide decision making. Performance will change depending on
455 circumstance (e.g., score status, momentum, coach instructions, weather), and so the extent to
456 which a player is performing to their strengths, showing their weaknesses, or developing new
457 traits, will not stay the same.

458 Strategic understanding of players and teams when learning to solve problems can be
459 enhanced by encouraging metacognition, such as predicting, checking, monitoring, testing and
460 controlling (Brown, 1987). For example, when seeking to learn about the performance of an
461 opponent, a player might plan to monitor his/her skill set during the initial phase of a game.
462 These are important ways of thinking for soccer players when problem solving, in an attempt
463 to understand when and why a problem has (or hasn’t) been solved. Players who have a deeper
464 understanding of their problem solving approach are also, we suggest, better equipped to tweak
465 how they solve the problem next time it is presented. As previously highlighted, our findings
466 indicate that players rarely use or recall any strategy to monitor and evaluate how they solve
467 problems. This is a crucial finding for coaches because, without preparing players and teams
468 with meta-level thinking strategies, it is likely game problems will take longer to solve.

469 Furthermore, a lack of evaluation and monitoring during problem solving will result in players
470 and teams who lack understanding of how to make progress in the game against an opponent.

471 When solving problems in soccer, controlling one's thought process to consider how
472 best to outwit the opponent will result in players and teams who can set stubborn problems
473 (and not just solve them). In the current study, it was uncommon for players to recall or
474 demonstrate how their use of knowledge would impact an opponent. Yet, soccer is considered
475 as a complex system where combinations of the game's rules and interactions between players,
476 form the basis of the problems to be solved (Grehaigne, Godbout, and Zeria 2011). Players
477 with a deep understanding are more aware of how the interdependency of these elements
478 develop as the game is being played (Gee, 2013). In other words, players who are thinking
479 metacognitively are capable of not just understanding a problem and solving it but can
480 influence the nature of a problem to make it less difficult to solve. In academic contexts the
481 ability to influence the difficulty of a problem is a common metacognitive skill (Ertmer and
482 Newby, 1996; McCrindle and Christensen, 1995). For soccer players and teams, the ability to
483 set a problem with a high degree of difficulty for the opponent is essential. Likewise, the ability
484 to deal with a problem by reducing its degree of difficulty is equally important.

485 *Implications for coaching practice*

486 For coaches to improve the depth of players' game understanding, and on what basis,
487 the current study highlights the benefits of using mechanisms to make player thinking overt
488 during naturalistic soccer related contexts. In short, that meta-level thinking and strategic
489 understanding are important elements which should receive explicit focus from early in the
490 development process. In line with previous studies in the domain of game understanding (cf.
491 Richards, Collins, and Mascarenhas 2016), we suggest one key mechanism for promoting overt
492 player thinking is 'slow off field' coaching. For example, coaching might include conversations
493 between player and coach or player to player about game problems that have recently occurred.

494 These conversations might include visual stimuli such as video footage, a tactical diagram or
495 tactic board. The findings of the current study offer an important contribution to Richards et
496 al. (2016); namely, the focus of conversations should not just be limited to solutions for
497 problems. Instead, conversations ought to extract and reflect on use of cognitive process and
498 strategy. We recommend the supporting probes in Table 1 (adapted from Militello and Hutton,
499 1998) as a useful start point for coaches to utilise for off field coaching conversations. This
500 type of questioning could be integrated into coach education qualifications as a core coaching
501 skill and framed to coaches as a tool for developing players depth of game understanding.
502 Notably, from the coach perspective, recent developments have stressed the importance of
503 considering alternative approaches, aimed at building deeper understanding of the process
504 (e.g., Collins & Collins, 2020). A similar approach can be used with players and developed in
505 coaches as a personal *and* coaching tool.

506 Nevertheless, coaching for cognitive process and strategy should not be confined to
507 ‘slow off field’ situations. Nor should coaching for cognition be used only *after* the problem
508 has passed; typically, how coaching teams often approach analysis and reflection on
509 performance (Wright, Carling, and Collins 2014). Instead, we suggest that practicing cognitive
510 process and strategy must also happen during ‘fast on field’ situations (Richards, Collins, and
511 Mascarenhas 2016), or in other words, in real time and as it is happening. Real-time context is
512 important for players to learn how to test and tweak their thinking, as the problem is unfolding.

513 Clearly, coach education has a role to play with prompting coaches to develop how
514 players think and not just what they think. One suggestion is for coach educators and coach
515 developers to be aware of and to fully understand new approaches emerging which may be
516 useful. Despite metacognition and the role of strategic understanding for team sport being
517 limited in both theory and practice, recent literature has recognised how a Digital Video Games
518 Approach (DVGA) (Price et al. 2017) can develop players’ metacognitive game skills

519 (Stephanou and Karamountzos, 2020). A DVGA is underpinned by five pedagogical principles,
520 which act in harmony to guide how a practice is designed and coached. The five principles are
521 intended to act as mechanisms which explicitly ask players to think about how they think about
522 playing the game, as they play it. For example, the principle of ‘pausing’ requires the players
523 themselves to decide when to pause play and with what and how they would like to be
524 supported or challenged (see Price et al. [2017] for a detailed overview of the five pedagogical
525 principles of a DVGA).

526 The benefits of making player thinking overt on or off field and in fast or slow
527 situations, will provide coaches with the opportunity to understand how players arrive at a
528 solution. Importantly, making player thinking overt during problem solving will show to what
529 extent they engage with cognitive strategy and the ways in which they control what knowledge
530 to use and when. We hope this will re-position how team games coaches perceive their role in
531 how players think about how they play the game. Our final message for coaches and coaching
532 practice is to consider the value in coaching for the problem-solving process itself, and not just
533 coaching to find and execute the solution to a problem.

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538 No potential conflict of interest was reported by the author(s).

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Table 1. *Supporting Probes for ACTA Interviews (adapted from Militello & Hutton, 1998)*

| ACTA Protocol | Probes |
|-----------------|---|
| Task Scenario | <p>How would your team play here, and why?</p> <p>What is your role in this, and why?</p> |
| Knowledge Audit | <p>Past and Future:</p> <p>Do you recall reading this situation?</p> <p>Do you recall feeling like you knew exactly how this situation arisen?</p> <p>Do you recall feeling like you knew where this situation was going?</p> <p>Big Picture:</p> <p>Can you tell me what is important for the team in this situation?</p> <p>What are the major elements you need to know and keep track of?</p> <p>Opportunities//Improvising:</p> <p>Can you recall making a decision to improvise in this situation?</p> <p>Can you recall noticing an opportunity to perform better?</p> <p>Self-Monitoring:</p> <p>In this situation, did you realise you needed to change what you were doing in order to achieve the desired outcome?</p> <p>Job Smart:</p> <p>When you acted in this situation, were there any ways in which you achieved more with less effort?</p> |
| Simulation | <p>What do you think is going on here?</p> <p>What is your assessment of this situation in this moment?</p> <p>What pieces of information led you to this assessment, and actions?</p> <p>As the player in this situation, what actions, if any, would you take in this moment?</p> <p>What errors would an inexperienced player likely make in this situation?</p> |

Table 2. *Categories of Learning Strategies (Weinstein & Mayer, 1986)*

| Cognitive Strategy | Cognitive Processes | Exemplar Data Extract | Meta-cognitive Strategy | Meta-cognitive Processes | Exemplar Data Extract |
|---------------------|---|---|-------------------------|--|--|
| Rehearsal | copying: reproducing something | Use the width. And make sure you have a diamond structure as well. | Strategy | selection of cognitive strategy | I was sure I was going to get the ball but just in case, I sort of had in my mind, that I would hold on to the ball for longer to see if his teammate came and doubled up on me. |
| | repetition: repeating something | We always play to one of our centre backs from goal kick. | | execution of cognitive strategy | So, I thought, I'm just going to do what he did, just get the ball and shoot. |
| | verbatim: quoting words and phrases | When the ball is here, we create triangles and shuffle up the pitch. | | | |
| Organisation | grouping: ordering information by connecting things together | I was looking for one of the midfielders to bounce off. But then there was none around, so then I just decided to clip it in. | | monitoring & control of cognitive strategy | I needed to have another look at his body shape next time he got on the ball... I don't see it properly the first time. Then I could see if it worked or not. |

| | | | | | |
|--------------------|---|---|---------------|---|---|
| Elaboration | categorizing: ordering information based on similarities or differences | Because if they say out wide, there's going to be a big gap in the middle and I would rather them play to the side-lines than through the middle of us. | Person | self-knowledge (my capabilities) | I'm a really composed player and I'm really relaxed, sometimes too relaxed on the ball. That's why I dropped deep and asked for it. |
| | mental note taking: paying attention to something specific to use later | If had to keep checking if there was anyone was coming behind me. And I had to keep on looking up in case there was a run being made. | | knowledge about others (teammates' and opposition capabilities) | Because he's left-footed I think, so that's on his weak foot as well. If he drops right the way down there. It would cause a problem for him. |
| | mental images: building internal associations | I knew I couldn't just kick it out because probably if I smashed it, it would hit one of their shins and there'd like been a scramble in the box. | Task | knowledge of the universal (beliefs about all human thinking) | In situations like that, it's what you can individually. He should be able to get past them if it's a one on one. |
| | self-questioning: checking one's own understanding | What if I lose it? Is someone there to like to give me an option or to like to help me recover? | | understanding how to approach learning | I was getting quite frustrated because I wasn't getting the ball and I wanted to impress the coaches. |
| | | | | recognition of how learning impacts ease or difficulty of task | Because like say he's pressing and he's coming towards me, it's a harder pass for him to go there, but if he drops his feet down like on the line there, it's an easier pass. |

Note: the authors removed the category of 'analogies' from this table because it contained no data.