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The evolution of student-coach's pedagogical content knowledge in a combined use of sport education and the step-game-approach model*

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ABSTRACT

Background: One of the essential elements within Sport Education is the inclusion of student roles and responsibilities. While previous research has examined students' performance in officiating tasks, the examination of student-coaches' pedagogical content knowledge (PCK) within peer-assisted tasks of Sport Education has been scarce. Indeed, the only study to date which has examined student-coach effectiveness was conducted by Wallhead and O'Sullivan [2007. "A Didactic Analysis of Content Development During the Peer Teaching Tasks of a Sport Education Season."*Physical Education and Sport Pedagogy* 12 (3): 225–243]. In that study, student-coaches struggled to manifest PCK by providing appropriate demonstrations, to diagnose errors, or to modify tasks for higher order content development. The study of PCK may be a useful heuristic to examine instructional effectiveness in physical education.

Purpose: The purpose of this study was to examine the evolution of the PCK of a cohort of student-coaches across three hybrid Sport Education-Step Game Approach seasons, and to examine the impact of protocols put in place to specifically enhance coaches' PCK.

Participants and setting: Twenty-one students and one teacher from a school class in the north of Portugal participated in the present study.

Method: Data from multiple sources were collected: (a) videotape observations of all lessons, (b) field notes, and (c) pre-lesson interviews with the student-coaches. These were then subjected to deductive examination through a process of thematic analysis.

Findings and conclusions: Following a baseline season that identified four key limitations within the student-coaches' instruction (task presentation, error diagnosis, feedback, and task modification), these students participated in specific coach preparation that involved modelling teacher's instruction, pre-lesson meetings, and coaches' corners. While showing marked improvement in their content knowledge across the second season, a second protocol was instigated during the third that involved the student-coaches to participate in stimulated reflections of their instruction and the incorporation of planning sheets to enhance their instruction. It was found that both interventions were efficacious in developing student-coaches' PCK, which allowed a more complete transfer of the instructional responsibility from the teacher to the students. These results give insight into the importance of including coach education protocols within the design of seasons of Sport Education with respect to student-coaches' instructional preparation.

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Model-based practice has been considered the 'great white hope' (Casey 2014, 19) and the 'wave to the future' (Dyson, Griffin, and Hastie 2004, 237) as a mechanism to replace the traditional teacher-centred practice in physical education (Metzler 2011). Sport Education is regarded as one of these innovative sport-based pedagogical models, and was designed to provide authentic and educationally rich sport experiences in the context of physical education (Siedentop, Hastie, and van der Mars 2011). The overarching goals of Sport Education are the development of competent, literate and enthusiastic sports players (Siedentop, Hastie, and van der Mars 2011), and reviews of research (Wallhead and O'Sullivan 2005; Hastie, Martinez de Ojeda, and Calderón 2011; Hastie 2012; Araújo, Mesquita, and Hastie 2014) have reported varying degrees of accomplishment of these goals. Perhaps the most up-to-date status on Sport Education research comes from Hastie (2012, 10) who suggested that evidence for competency is 'burgeoning and developing', support for literacy is 'emerging', and that enthusiastic responses by students have been 'significantly substantiated'.

Central to the concept of Sport Education is the persisting team, and within this team the allocation of students to roles other than player. Examples of *within team* roles include coach, equipment manager, or fitness leader, while those *within match* roles include referees, scorekeepers, and statisticians. Studies in Sport Education that have specifically examined role involvement report that students enjoy taking these administrative roles and achieve high levels of congruent behaviours when officiating games (Hastie 1996; Hastie and Sinelnikov 2006; Layne and Hastie 2014).

Apart from officiating, the other central role within Sport Education that is different from more traditional physical education is the student-coach. This player is expected to provide general team leadership, to direct skill and strategy practice, and to make decisions about team line-ups (Siedentop, Hastie, and van der Mars 2011). However, with the exception of the study of Wallhead and O'Sullivan (2007), there has been no examination of student-coaches' instructional competence within peer-assisted tasks. It is therefore not surprising that several authors have called for the analysis of student-coach leadership skills and instructional competence within the peer-assisted tasks in Sport Education (Hastie 2000; Wallhead and O'Sullivan 2005; Hastie, Martinez de Ojeda, and Calderón 2011). This is particularly relevant given Wallhead and O'Sullivan's finding that student-coaches' struggled to elaborate content through appropriate demonstrations, error diagnosis, and task modification.

In terms of examining teaching/coaching effectiveness, the concept of pedagogical content knowledge (PCK; Shulman 1986, 1987) is seen as a particularly appropriate heuristic. Indeed, PCK has been studied specifically within the context of Sport Education (e.g. Stran and Curtner-Smith 2010; Iserbyt, Ward, and Martens 2016), but only where the focus has been on the class teacher, rather than the student-coach. PCK can be described as a form of content knowledge (CK) where a teacher modifies content in order to help students learn and understand the subject matter. Within physical education, CK can be classified into two domains, specifically common content knowledge (CCK; knowledge of the rules, techniques, and tactics needed to perform the task) and specific content knowledge (SCK; knowledge of students' errors and instructional tasks that can be used to teach CCK) (Ball, Thames, and Phelps 2008). PCK involves decisions about SCK in the context such as knowledge of the students' characteristics and experiences with the content, the setting and pedagogy (circuit, direct instruction, etc.) (Hill, Ball, and Schilling 2008). PCK, then, could be thought of as the aggregation of several knowledge bases as the teacher makes decisions about what and how to teach.

Within Sport Education, different scenarios are available that could represent the interface between the teacher's and student-coach's CK and PCK. Examples of these are shown in Figure 1, which represents a gradual shift in the responsibility for decisions and instruction from the teacher to the student-coach. In the first scenario, the teacher is in control of all content decisions and is responsible for most of the instruction. Here, the role of the student-coaches is simply to transmit the task requirements and CCK to teammates. Moving downwards sees an increased level of responsibility taken by the student-coaches, in that they also give feedback cues provided by the teacher to their teammates (SCK). Later, the teacher might only suggest SCK to student-coaches (tasks,
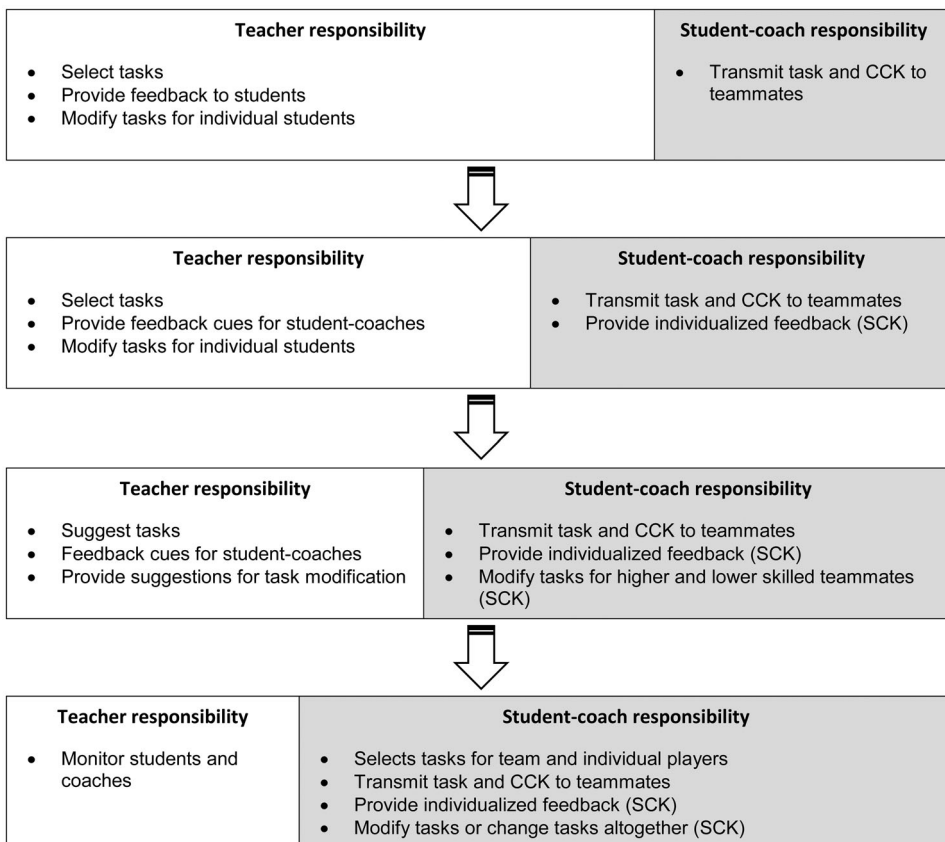
Figure 1. Different scenarios that could represent the interface between the teacher's and student-coach's CK and PCK within Sport Education.

feedback, and task modification), and hold them responsible for transmitting these to their team-mates (in which case, the student-coach needs both CCK and SCK). In a most autonomous scenario, the student-coaches might be given full responsibility for the instruction of their teams (e.g. selecting and transmitting tasks for the team and individual players, providing individual feedback, and modifying tasks when required). In this final scenario, the teacher's responsibility is to monitor the success of the student-coaches and their teammates.

Given the central place of the student-coach within Sport Education research, and given the paucity of research on student-coaches in general, the purpose of the present study was to examine the evolution of student-coaches' PCK during three hybrid Sport Education-Step Game Approach (SGA) seasons. Furthermore, the study also sought to assess the effectiveness of specific coach training protocols on the evolution of student-coaches' PCK. That is, we sought to identify those features which proved problematic in moving student-coaches towards higher levels of PCK during peer-assisted tasks, and to then evaluate the teacher interventions that were put in place designed to address those difficulties.

Method

Participants

At the commencement of the study, the participants consisted of 21 students (11 boys and 10 girls, average age = 12.0) from one high school physical education class in the north of Portugal. The class

met twice a week, with one lesson scheduled for 45 minutes and the other for 90 minutes. The teacher who presented the three seasons had more than 20 years of teaching experience, and 2 years of applying Sport Education prior to this study. For all students, however, this was their first experience with the model. The ethical committee of the authors' university approved the research protocol. To guarantee students anonymity and to distinguish their opinions, all the participants were provided with pseudonyms: the student-coaches were Afonso, Cláudio, and Tiago; and peer-participants were Ana, Alexandre, Cristiana, Diana, Isabel, Mário, Patrícia, and Rúben.

Design of the study

This study followed a longitudinal design that included three hybrid Sport Education and SGA volleyball seasons and two protocols of student-coaches' preparation over three years. The study started when students were in the 7th grade and ended during their 9th grade year. Given that the specificity of content can influence the evolution of student-coaches' PCK, the same sport was used across the three years (i.e. volleyball). Since the Portuguese physical education curriculum allowed for teaching only one volleyball unit per school year (7th, 8th and 9th), each of the three seasons was separated by approximately 12 months. In the time between the three seasons, neither Sport Education nor SGA models were implemented during physical education lessons, and none of the content related to volleyball. Each of the three seasons lasted between 20 and 25 lessons, and contained all the features of Sport Education (i.e. seasons, persisting teams, formal competition, record keeping, festivity, and a culminating event) that represent full implementation of the model. The students also remained in the same class throughout the entire study and despite some minor player changes from one season to the next, the make-up of the teams and student-coaches maintained consistent throughout the entire study. Table 1 provides a complete outline of the season plans for each of the three seasons.

The sport education features

Each of the seasons was divided into phases of skill and tactical development, non-consequential practice matches, and formal competition. The purpose of the early lessons was to address the educational goals and procedures embedded in Sport Education, and the allocation of students into mixed-ability teams (according to pre-unit assessments of the students). In the first two seasons, students were allocated to four teams and to only three in the third season. The roles taken within each team were players, student-coaches, equipment managers, statisticians, and referees. The second phase of each season was dedicated to within-team practices, learning about officiating responsibilities, and scrimmage game play and formal competition. In the final phase of the season, a culminating event was organized.

The SGA features

The SGA (Mesquita et al. 2005) provides an appropriate framework for the development of game play ability in net sports; such is the case of volleyball (Araújo et al. 2016). In this model, students are presented with progressive (step-by-step) game problems that challenge their capacity for understanding and current performance profiles. During the first season, the first step game was applied. The main goal was for students to learn the simplest game form (1vs1). Two main tactical skills, namely *intervention* and *opposition* and two technical skills, namely the *overhead pass* and *underhand serve* were taught. Nevertheless, given the simplicity of the 1vs1 game, 2vs2 games were introduced towards the end of this season. The second season was dedicated to the second step of SGA. More specifically, the main goal was to achieve the ability to *cooperate* with a partner while challenging opponents, which requires that players take different roles in the attacking phase. In this way, while the 2vs2 game was again taught during this second season, three specific tactical skills were introduced. These included (i) *watching the opponents' placement*; (ii) developing verbal

Table 1. Unit plans for the three sport education seasons.

First unit	Second unit	Third unit
Lessons 1 and 2	Lesson 1	Lesson 1
Explanation of the model and competition format	Explanation of the competition format and handbooks	Explanation of the competition format and handbooks
Allocation of teams and individual roles	Allocation of teams	Allocation of teams
Teacher-directed instruction: overhead pass, 1vs1	Student-directed instruction: warm-up	Friendly competition: 2vs2
Within-team practice	Teacher-directed instruction: overhead pass and 2vs2 (position in court and verbal communication)	Lessons 2–4
Lessons 3–6		Student-direct instruction: warm-up, 2vs2 game and overhead pass in a linear trajectory
Teacher-directed instruction: overhead pass, 1vs1 (displacement and position in court)	Lessons 2 and 3	Within-team practice and role practice (shared teacher- and student-directed monitoring)
Within-team practice	Student-directed instruction: warm-up, overhead pass and 2vs2 (approach to the net by the setter)	Formal competition: 2vs2 with specific rules
	Lesson planned by the teacher	Statistics and refereeing (ball in/out and permission to serve)
Lessons 7–10	Within-team practice and role practice (shared teacher- and student-directed monitoring)	
Student-directed instruction: warm-up, overhead pass and 1vs1 (opposition)		Lessons 5–8
Lesson planned by the teacher	Lessons 4–6	Student-direct instruction: warm-up, overhead pass in a non-linear trajectory, verbal communication and different functions in 2vs2
Within-team practice and role practice (shared teacher- and student-directed monitoring)	Student-directed instruction: warm-up, overhead pass (non-linear trajectory) and 2vs2	Within-team practice and role practice (shared teacher- and student-directed monitoring)
	Lesson planned by the teacher	Formal competition: 2vs2 with specific rules to promote verbal communication
Lessons 11–16	Within-team practice and role practice	Statistics and refereeing (ball in/out and permission to serve)
Student-directed instruction: warm-up, underhand serve and 1vs1 (opposition)		
Lesson planned by the teacher and students had the opportunity to plan some learning tasks	Lessons 7–16	Lessons 9 and 11
Within-team practice and role practice	Student-directed instruction: warm-up, overhead pass (non-linear trajectory) and 2vs2	Student-direct instruction: warm-up, transition and opposition
Formal competition: 1vs1	Lesson planned by the teacher	Within-team practice and role practice
	Within-team practice and role practice	Formal competition: 2vs2 with specific rules to promote the approach of the setter to the net in the 2nd touch
Lessons 17–24		Statistics and refereeing (more than one touch for player and three for team)
Formal competition: 1vs1 and 2vs2	Lessons 13–16	
Student-directed instruction: warm-up, 1vs1, and 2vs2	Formal competition: 2vs2	Lessons 12–14
Lesson planned by the teacher with students having the opportunity to plan some learning tasks	Student-directed instruction: warm-up, overhead pass (non-linear trajectory) and 2vs2	Student-direct instruction: warm-up and forearm pass
Within-team practice and role practice	Lesson planned by the teacher	Within-team practice and role practice (student-directed monitoring)
	Within-team practice and role practice	Formal competition: 2vs2 with specific rules to promote opposition
Lesson 25		Statistics and refereeing (all the rules)
Culminating event	Lessons 17–19	
	Formal competition: 2vs2	Lessons 15 and 21
	Student-coaches and their teams planned content and learning tasks to the lesson	Student-coaches and their teams planned content and learning tasks to the lesson
	Within-team practice and role practice	Within-team practice and role practice (student-directed monitoring)
		Formal competition: 2vs2 with larger courts
	Lesson 20	Statistics and refereeing
	Culminating event	
		Lesson 22
		Culminating event

communication; and (iii) *assigning accountability zones.* Additionally, the *forearm* pass was also taught, since the students needed other technical skills to play the ball with lower and faster trajectories. The assessment test prior to the third season revealed two distinct skill levels within the class. Some students were ready to learn the third step of the SGA, but other students were still having difficulties with the 2vs2 game. Variations to the learning tasks and game rules were implemented

during this third season in order to adjust the difficulty of learning tasks across different skill levels. In addition, while graded competition was maintained in terms of similarly skilled opponents, the games themselves also differed in terms of rules, court dimensions, and scoring. As an example, higher skill-level students played the 2*vs*2 on bigger courts and without any adaptation to the regulations (more touches per player, rebound, etc.). On the other hand, lower skill-level students not only played on smaller courts but also were allowed more than one touch per player or three per team. The three seasons used all types of instructional tasks (*acquisition*, *structuring*, and *adaptation*). Specifically, *acquisition* tasks emphasized the development of a particular skill, structuring tasks were focused on comprehending the tactical and technical skills of the game, maintaining its structure but without opposition, and *adaptation* tasks in which the goal, action structure, and basic tactical features are identical to the full volleyball game. In addition, most task modification was based upon the concepts of *representation* and *exaggeration*.

Protocols of student-coaches' preparation

The purpose of the first Sport Education season was to act as a baseline in which data were collected to identify any instructional difficulties of the student-coaches within peer-assisted tasks. Based on those limitations, a protocol for student-coach preparation was developed. The impact of this protocol was examined throughout the second season, in which the focus was on both improvements in student-coaches' PCK as well as possible remaining difficulties. A second (and somewhat different) protocol for student-coaches' preparation was subsequently developed for implementation during the third season.

Data collection

In order to analyse the student-coaches' PCK during peer-assisted tasks and the perceptions of all the participants in regard to student-coaches' performance, data from multiple sources were collected. These included: (a) videotape observations of all lessons, (b) field notes, and (c) pre-lesson interviews with the student-coaches.

To record all lesson and meeting events, a portable video camera situated in an unobtrusive way in the corner of the gymnasium was mounted on a tripod. In addition, the three student-coaches wore wireless microphones. This allowed for capturing the visible and audible actions, as well as the interactions of all the participants (Pink 2007). In particular, the use of a microphone gave better access to the dynamics between the student-coaches, peer-participants, and the teacher.

Along with videotape observation, the first author took field notes during each lesson in order to record his beliefs, perceptions, and personal experiences about each lesson. In addition, a detailed description of the setting, the students' responses to various events taking place during the lesson, as well as the student-coaches' interactions with their teammates were also included. Direct quotations were noted and observer comments were placed in the margin relative to feelings, hunches, and initial interpretations. Informal conversations with both the teacher and students were also used to seek further reactions to the lesson and were added to the field notes.

In order to clarify what student-coaches understood from the pre-lesson meeting with the teacher, and how they would organize their teammates in the upcoming lesson, pre-lesson interviews were conducted, also by the first author. Sample questions included: 'What content will be taught in the upcoming lesson?' (CCK), 'How will tasks be organized during the lesson?' (SCK), 'What are the main objectives of each of the practices you are going to coach today?'(SCK), 'How do you think your teammates will perform during the lesson?' (PCK), and 'Do you foresee any problems with any of your teammates today?' (PCK). Although the order of questions varied (since they were built on the participants' responses), efforts were made to guarantee that they were presented in a similar sequence (Irwin, Hanton, and Kerwin 2004). Furthermore, prompts and follow-up questions were used to obtain further clarification of responses (Patton 2002).

Data analysis

Videotape records and interviews were transcribed verbatim and labelled (title, date, time, and lesson number), in order to ensure a complete and accurate record of the data. Additionally, field notes were entered into the file for the appropriate day. These two processes ensured an accurate account of the sequence of events and quick retrieval of specific occurrences or lessons.

In order to reflect thoughts and interpretations of the researchers, the transcripts were read several times with notes being placed in the margins. In the next phase of analysis, these data were subject to a deductive analysis (Gilgun 2011). That is, the existing theory and research regarding PCK guided the authors in the analysis of student-coaches' evolution across the three seasons. In this deductive form of analysis, the theory provided a source of initial codes, and the findings from the three seasons were examined in terms of where they confirmed, added to, or provided negative cases (Elo and Kyngäs 2008; Gilgun 2011). Representative cases of student-coaches' PCK obtained from lesson observations, interviews, and field notes were selected, and are presented in the results to highlight the research team's point of view. It should be noted, however, that these representative cases were not the sole example, and there was evidence of these behaviours being systematically observed throughout the study.

Results

Season 1 – providing a baseline of student-coaches PCK

Three themes were identified from the data that best portray the challenges faced by the student-coaches during the first volleyball season. These have been given the following labels: (i) struggles in organizing and presenting tasks, (ii) lack of error diagnosis and feedback, and (iii) no evidence of task modification.

Struggles in organizing and presenting tasks (struggling to transfer CK from the teacher to the students)

The three student-coaches appeared to experience several difficulties in terms of task presentation during all lessons of the season. More specifically, they failed to explain some important issues like where students should stand, how long they should stand, how long they should practise, what each student should be doing, as well as the goals and key points of the task. As a result, throughout the season, the teacher was often forced to intervene when a new task was presented. The following excerpt of lesson observations supports this idea:

> During the entire lesson, Afonso often seemed to not understand what tasks were supposed to do with his team. Every time Afonso presented a new task [acquisition or adaptation tasks] he was often forced to ask for the teacher's help as he appeared to be unsure of exactly what the teacher expected him to do. (Field notes, lesson 7)

Lack of error diagnosis and feedback (no evidence of SCK)

Throughout the season, the three student-coaches struggled to identify the technical and tactical elements of volleyball content, even in the simplest tasks (e.g. acquisition tasks). As a consequence, they were unable to identify performance errors in teammates. Several lesson observations throughout the season showed occasions during peer-assisted tasks where the three student-coaches should have intervened and given feedback but failed to do so.

> In this simple acquisition task, none of the members of Tiago's team are appropriately positioning their bodies in order to send the ball where they need. However, Tiago did not provide feedback. (Field notes, lesson 10)

When feedback was given, it had a more motivational focus (e.g. general praise) or was related to the organizational features of the task. Moreover, when the feedback was related to the content, it did not emphasize the key points of the task, or was not congruent with the focus of the task. The intervention of Cláudio during lesson 13 clearly exemplifies this difficulty:

> Patrícia is not having success in the task [n.r. the transfer of the body weight]. While the appropriate feedback would have been to encourage her to transfer her body weight to the forward foot, Cláudio is providing feedback about hand position instead. (Field notes, lesson 13)

No evidence of task modification (no evidence of SCK)

Throughout the season, there was no evidence of the student-coaches making changes to the tasks when teammates were experiencing difficulties. These changes may have included allowing teammates to move close to the net when serving, allowing more than one touch per player, or to catch and toss the ball instead of performing the traditional overhead pass. The following excerpt exemplifies the absence of task modification:

> The three teams were performing the same drill, specifically designed to practice the overhead pass in a non-linear trajectory [n.r. acquisition task]. All students were experiencing difficulties in sustaining the ball and the three student-coaches did not facilitate the task (perhaps by allowing more than one contact per player). (Field notes, lesson 17)

Season 2 – fading instructional responsibility from the teacher to the student-coaches

Student-coaches' preparation

The instructional difficulties experienced by the student-coaches during the first season reinforced the need to provide them with specific tools during the second season in order to enhance their basic instructional skills (such as organization of the tasks, simple feedback, and task modification). This preparation included: (i) teacher modelling (which included SCK in the form of knowledge about the tasks, and CCK in terms of technical and tactical skills), (ii) a pre-lesson meeting with the student-coaches, and (iii) a coaches' corner strategy. Table 2 outlines the student-coaches' instructional preparation throughout the season.

Providing student-coaches with basic instructional skills through increased CK

During the first six lessons of the season, the teacher modelled a number of instructional skills for the student-coaches. The purpose was to increase student-coaches' vocabulary (i.e. extended CCK) which they could use when organizing their teams. First, he provided information about the task to the whole class (such as task structure and key points), but it was only the student-coaches who then organized the tasks with their teammates.

> The teams were practising the attack organization of a 2vs2 side-out structure. The teacher stopped all the teams and presented a new task, namely a 2vs2 within-team practice game. He also recapped the rules and key points of the game. After the task presentation, teams immediately started the intended task. (Field notes, lesson 1)

In addition, the responsibility for monitoring performance during learning tasks was shared by the teacher and the student-coaches in an effort to enhance their SCK. This served to increase student-coaches' awareness when they were providing feedback.

> Alexandre was not having success in the underhand serve, since he was stepping onto the wrong foot. Afonso did not intervene. The teacher called Alexandre and provided him a corrective feedback. In the following attempt Alexandre also did not advance the correct foot. Nevertheless, Afonso immediately provided feedback. Alexandre tried again and properly executed the serve. (Field notes, lesson 1)

Table 2. Student-coaches' preparation of the second season.

Instructional skills improved		How they were developed
CK • Devolution of rules and technical and tactical basic knowledge of the game form to be taught *Task presentation* • Goals orientation of the task to be performed	Lessons 1–6	*Teachers' modelling.* This was accomplished by student-coaches modelling teacher's instructional intervention during the lesson. The teacher provided information of the task to the whole class (such as task structure and key points of the task) before student-coaches organize the tasks with their teammates. Additionally, together with the teacher student-coaches shared the monitoring of teammates' performance during learning tasks
• Organizational arrangements of the task: space, time, task structure and students' functions *Feedback* • Critical components of technical and tactical skills required for each of the upcoming tasks. • Recognition of the most common errors during the task *Task modification* • Possible task modifications when needed: changing the dimensions of the court, the technical skill to be used, number of players per group, etc.	Lessons 7–20	*Teacher's pre-lesson meeting.* The teacher transmit and demonstrated the content to be taught and the learning tasks to be organized on the upcoming lesson by the use of diagrams and handbooks; highlighted the key points in which student-coaches should be focused during task monitoring and exemplified possible task modifications *Coaches' corner.* Every time the teacher presented new content, a new task or a modification to the on-going task he gathered the student-coaches and provided them with the key points of the tasks and content to be taught while the rest of the students continued to participate in the task

Pre-lesson meeting

From lessons seven onwards, the student-coaches were progressively called upon to organize and present tasks to their teammates. In order to better release the instructional responsibility from the teacher to the student-coaches, a pre-lesson meeting with the student-coaches was included. During these meetings, the teacher informed the student-coaches about the organization of the lesson, the key points which they should focus on during task monitoring, as well as potential task modifications. The meeting was held in the gymnasium immediately before each lesson with peer-assisted tasks and lasted between 5 and 10 minutes. The following extract from one meeting is typical of these used:

> Teacher: '[…] You are going to organize a 2*vs*2 game without opposition with your teammates. This drill will count to our competition […].'
> Cláudio: 'Do we need to count the number of times we touch the ball?'
> Teacher: 'No … You need to count the number of times the ball crosses the net after 3 touches. If you only perform 2 touches per team it will not count but it will also not return to zero [the teacher draws a diagram showing the organization of the task].'
> Tiago: 'But do we need to serve?'
> Teacher: 'No … If anyone has difficulty keeping the ball in play, just grab it and continue the drill.' (Teacher's meeting with the student-coaches, lesson 11)

Coaches' corner

During this period (from lesson 7 onwards) of the season, the teacher also began to use a coaches' corner strategy. Every time the teacher presented a new content, or a task modification to the ongoing task, he gathered the student-coaches and provided them with the key points of the tasks and content to be taught while the rest of the students continued to practise. Moreover, the student-coaches had the opportunity to ask the teacher any questions they might have related to the task. The following excerpt from one coaches' corner observation exemplifies this strategy:

All students were practising in their teams. Before the teacher began the competition, he wanted to remind student-coaches the key points and rules of the game. He therefore called the student-coaches to a corner of the gymnasium.

Teacher: 'Next, game 2*vs*2 with opposition. During this game, do not forget to remind your teammates about the rules of the game. When do you rotate in the serve?'

Tiago: 'When we win the serve.'

Afonso: 'But, we only serve a maximum of two serves and then we rotate?'

Teacher: 'Yes. More rules: one touch per players and three per team. Do not forget to communicate and approach the net. But now, you need to inform your teammates to execute the forearm pass when the trajectory is low and overhead pass when the trajectory is high. Ok? Let's go!' (Field notes and video observation, lesson 9)

The evolution of student-coaches' PCK

With respect to the outcome of the pre-lesson meetings, the student-coaches showed an improved level of understanding of the structure of each lesson task. Consequently, they started to organize simple (i.e. acquisition tasks) tasks with their teammates by communicating the general organization of the task, general goals (i.e. technical and basic tactical skills) and teammates' functions within the task. An extract from the pre-lesson interview and subsequent video observation provides a representative example of Afonso's improved understanding of task structure and the presentation of it to his teammates:

Researcher: 'What will you do with your teammates during today's lesson?'

Afonso: '[…] We will have a 2vs2 situation without opposition […] I will pay attention to the 3 touches per team, to the verbal communication and to the movement to the net before the set'. (Afonso, pre-lesson interview, lesson 9)

The pre-lesson meeting appeared to help student-coaches in developing CCK regarding the technical and basic tactical skills (e.g. communicate and approach the net to set) of the content being taught. The following excerpt shows that Afonso knew exactly the goals of the tasks and the key points in which he would be focused on:

Researcher: '[…] What are the goals and tasks for today's lesson?'

Afonso: '[…] One player is serving and other two receiving. After the serve they need to communicate and the non-receiver must approach the net to set.'

Researcher: 'As a coach, what will you be focused on?'

Afonso: 'I want them to execute three touches, to communicate when they will receive the ball and approach the net to set.'(Afonso, pre-lesson interview, lesson 9)

The student-coaches also improved their SCK, in particular, their ability to diagnose errors and provide appropriate feedback regarding those technical and basic tactical skills during simple tasks (i.e. acquisition tasks). This argument is supported by the observation of increased cases where they were able to provide congruent feedback:

In this acquisition task, students only had to communicate and touch the ball after an easy serve. When Diana did not play the ball in her responsibility zone, her coach stopped the play and said: 'Diana all this space of the court is yours … This entire rectangle of the court is your responsibility. You only move to the net to set if your teammate is about to receive the ball.' (Field notes and video observation, lesson 12)

Another example of the student-coaches' improvement was the introduction of task modifications, although these were limited only to cases of representation (i.e. when teammates were having difficulties with technical issues or the actual rules of the small-sided game). Furthermore, these modifications were only evident during acquisition tasks.

Ana was having difficulties in sustaining the ball in a non-linear trajectory. Tiago allowed her to execute more than two touches if necessary until her body was placed to the target. (Field notes, lesson 11)

The last indicator that showed the student-coaches' improvements was the release of instructional responsibility from the teacher to the student-coaches. Taking into account the student-coaches' improvements with respect to task presentation, feedback and task modification, the teacher chose only to intervene: (i) in response to critical incidents (e.g. sporadic disciplinary incidents); (ii) when there was lack or inadequate feedback; or (iii) when he wanted to introduce new or more complex content.

> The teacher spent the majority of the lesson observing and praising students' effort. Teacher's intervention was only needed to organize the coaches' corners (when he needed to change the task), answering student-coaches' doubts regarding the organization of the competition matches (time and sub teams) and providing feedback when student-coaches were not able to diagnose some complex content on game-like tasks. (Field notes, lesson 18)

Student-coaches' remaining difficulties (lack of advanced level of SCK)

Despite the several improvements observed, the student-coaches still often failed to specify the critical components of the tasks (i.e. key aspects related to the goals of the task) and there were almost no examples of the use of demonstration. The following example highlighted the lack of these two aspects during task presentation.

> In order to develop verbal communication in a structuring task, despite Tiago has given information to his teammates regarding the organization of the task, yet they seemed confused with his presentation. He did not use demonstration and did not specify the critical components of the task. Indeed, during the majority of the time allocated for this task, teammates seemed continually in doubt regarding the task structure. (Field notes, lesson 17)

Furthermore, the coaches provided feedback only during acquisition tasks and for basic tactical skills. In more complex tasks (such as structuring and adaptation tasks) or more complex tactical content (for instance, opposition), any feedback given was for the most part not related to the goal of the task.

> The goal of this game-like task (2*vs*2 game without opposition) was to sustain the ball, with the first touch directed to the net and a movement from the non-receiving player to the net before the set. However, Afonso continued to reinforce the need of using three contacts on the ball. (Field notes, lesson 11)

Feedback also could be characterized as following a prescriptive and evaluative profile, with questioning rarely being used. The following two examples from Afonso's performance during lesson 11 provide support for this contention:

> Afonso: 'Alexandre you have to set the ball higher … Set higher! Set higher! […] Stop Alexandre. I will toss the ball to you and you will set the ball higher … Higher! Higher!' (Field notes, lesson 11)

The student-coaches also failed to modify the task when it was necessary to focus teammates' attention towards a key aspect of technical or tactical content (i.e. modification by exaggeration) even in simple acquisition tasks:

> During one 2*vs*2 side-out drill, the players were having success in sustaining the ball but without accomplishing the goal of the drill (approach to the net). Cláudio could focus students' attention on this tactical skill by giving extra points every time they approached the net. (Field notes, lesson 17)

Season 3 – development of higher levels of PCK

Student-coaches' preparation

In order to transfer all in-class responsibility from the teacher to the student-coaches, it was necessary to prepare them with respect to four instructional strategies. These included: (i) the use of demonstration and the definition of the critical components of the task during task presentation; (ii) the provision of feedback during more complex learning tasks (i.e. structuring and adaptation tasks) and

Table 3. Student-coaches preparation during the third unit.

Lessons 2–10	Meetings 1–4	In the first part of the meeting, the teacher provided feedback to coaches through the use of videos from previous lessons. The focus was on the students' instructional performance during the learning tasks:
		- Improving student-coaches' task presentation - How to sequence the presentation: understand the task goals after task organization - Using a clear and objective language: use demonstration, avoid digressions and ambiguous phrases, detailed and redundant information - Provide critical components or/and criteria of success to each of the task for the upcoming lesson - Improve feedback in tasks with more tactical demands - The use of questioning - Presented practice situations in which the feedback was insufficient, and encouraged the student-coaches to modify the task
		In the second part, the teacher used the planning sheets to explain the content and learning tasks used in the following lessons. Sometimes he also demonstrated the task or the content. Discussion with the teacher guidance of the critical components and most frequent errors of each of the tasks planned for the upcoming lesson
Lessons 11–22	Meetings 5–7	In the first part, the teacher presented videos of SC's instructional performance and asked students to reflect about their performance
		In the second part, the teacher presented videos of each team playing, and asked student-coaches to then describe how they would structure their future practice sessions. This was accomplished by the elaboration of planning sheets

content (more complex tactical skills, such as opposition); (iii) the use of questioning; and (iv) the use of task modification by representation.

Therefore, the teacher initiated a series of extracurricular meetings with the student-coaches. These meetings, which took place once a week and lasted between 28 and 70 minutes, took place in a classroom outside the gymnasium. Within these meetings, the teacher showed the student-coaches sample video clips of their coaching in order to help them analyse all the learning tasks of the previous lesson, and then to debate their opinions.

In the first phase of the student-coaches' preparation (until lesson 10), the teacher focused the student-coaches' attention onto the aforementioned aspects of their instruction. From the middle of the season, the teacher provided questions, hints, and cues based on videos, in order to increase the student-coaches' ability to solve problems they could face during peer-assisted tasks.

The second instructional strategy adopted by the teacher during these extracurricular meeting was the use of planning sheets which could be used by the student-coaches during the lesson. During the early lessons of the season, these planning sheets outlined the task structure, content to be taught, key points, common errors, as well as examples of possible feedback and task modification. Later, they were designed to elicit the debate between the three student-coaches and the teacher regarding what student-coaches thought was necessary to practise with their teams, as it was at this time that the student-coaches took full responsibility for practice planning. Full details of these extracurricular meetings are provided in Table 3.

The evolution of student-coaches' PCK

The interventions introduced during this third season seemed particularly effective in improving student-coaches' task presentation through increases in their CCK. Evidence to support these was seen in the use of demonstration. Specifically, the three student-coaches began to use demonstrations, and also provided the critical components for successful completion of the tasks. The following excerpts exemplify how task presentation was developed during the protocol of this third season, and the subsequent improvement of student-coaches during the lesson:

The teacher explained the key issues of task presentation: place the teammates in their places, explain and demonstrate the task, define the key points of the task and check teammates' understanding. (Field notes, extracurricular meeting, before lesson 5)

The student-coaches are continually using their planning sheets. For instance, before the presentation of the tasks of this lesson, the three student-coaches consulted their planning sheets to check the structure and the key points of the task. (Field notes, lesson 12)

In the 'butterfly' task [n.r. complex adaptation drill with opposition] Tiago has provided a detailed explanation of the tasks to his teammates, including demonstration and the critical components of the task that were developed during the last meeting.

Tiago: 'Ok. In the next drill I want you to do two things: communicate with your teammate by saying "mine" and move to the net if your teammate says "mine". Don't worry we can do this. Our field is this. Rúben stays here, Cristiana here and Isabel there with ball. So, Isabel serves, Cristiana receives and says "mine", Rúben moves to the net, sets the ball and Cristiana execute the attack to the other side and tries to score. Then, you change places: Pedro serves, Tatiana goes behind Pedro and Isabel comes to receive. Let's do it one time so everyone can understand [and demonstrates the drill].' (Field notes and video observation, lesson 9)

With respect to the provision of feedback, all three student-coaches showed that they were able to diagnose errors and to provide appropriate feedback focused on the critical components of the task in structuring and adaptation tasks, and in the presence of more complex tactical content (such as, opposition):

The extracurricular meeting previous to this lesson was focused on the student-coaches' difficulties on error diagnosis and feedback. For instance, during this adaptation tasks that is focused on opposition, the student-coaches were helping their teammates to look to the other side after sending the ball, in order to put the ball in the vulnerable zone of the opposite team. (Field notes, lesson 10)

These meetings are helping us in our role as coaches. Unlike the case of the previous season, in this season you [n.r. the teacher] explained the lesson plan to us, what we have done right or wrong, etc. […] I feel more competent as a coach. (Afonso, extracurricular meeting, before lesson 10)

During the extracurricular meetings, Afonso and Tiago raised the possibility that using questioning would encourage their teammates to think about their own difficulties.

Two examples of student coaches' intervention were presented to them in this extracurricular meeting: prescriptive and questioning feedback, respectively. Then, student-coaches were asked about the differences between the two interactions.

Teacher: 'What is the difference between these two?'
Tiago: 'In the first video [n.r. prescriptive feedback] I explained to them what was supposed to happen. In the second [n.r. video with questioning] I tried to ask my teammates so they could find their errors by themselves.'
Teacher   'So, our feedback can also be like …'
Afonso: '… a question'.
Teacher: 'Exactly. What do you think is the best way to communicate with your teammates?'
Tiago: 'Questioning. In this way, they are obligated to think.' (Field notes and video observation, extracurricular meeting before lesson 15)

The following example shows how Tiago had progressed from using more prescriptive feedback during earlier lessons (lesson 6) to the greater use of questioning in the latter lessons of the season (lesson 16).

Tiago to Alexandre: 'Set the ball to your teammate. Do not send the ball here. Send there! […] Like I sent to you just now. […] But don't set so high. […] Do not move from the targets […] Higher than that […] Do not set the ball immediately. Receive, wait, place the body and set. […] What you have to do is: receive, place the body and only then set!' (Video observation, lesson 6, Tiago)
Tiago: 'Alexandre, where did the ball go? Where did the ball touch the floor? In which zone?'
Alexandre: 'Here? [n.r. the zone of his responsibility]'

Tiago:	'Correct! Here. Who has to play this ball?'
Alexandre:	'Me.'
Tiago:	'Why?'
Alexandre:	'Because this is my responsibility zone.'
Tiago:	'Are you understanding now?'
Alexandre:	'Yes'
Tiago:	'Good! Lets' try again.' (Video observation, lesson 16, Tiago)

Throughout the season, the three student-coaches also showed the ability to modify tasks by representation (number of contacts per player, technical skill used, number of players, task criteria, etc.) not only in acquisition tasks as was the case in the previous season, but also during structuring and adaptation tasks. Furthermore, Afonso and Tiago were able to modify the tasks to focus students' attention on a critical task component (modification by exaggeration).

> The teacher presented to the student-coaches a video in which Tiago was giving feedback to Alexandre but he continued not having success in the task.
> Teacher: 'What can we do in these situations? Sometimes, if our feedback is not enough we can modify the task.' (Video observation, extracurricular meeting before lesson 8)
>
> Tiago perceived that his teammates would not accomplish two critical components of the task (verbal communication and approach the net before the set). Therefore, he added points every time some teammate accomplished these two components. (Field notes, lesson 15)

Given these student-coaches' PCK improvements, there was a more complete transfer of the instructional responsibility from the teacher to the student-coaches. That is, the student-coaches planned the lesson, presented the tasks, provided proper feedback and applied task modification whenever necessary.

> It's almost like the teacher was not needed during this lesson. He even had the time to leave the lesson for a while and the students stayed engaged in the learning tasks. During this lesson I only saw the teacher observing, praising students' effort, informing student-coaches the times of the lesson (initiate/ending of the lesson, change tasks, initiate competition, etc.) and recording teams' winnings in the end of the lesson. (Field notes, lesson 16)

Discussion

The purpose of the present study was to examine the evolution of student-coaches' PCK across three Sport Education-SGA units. The results showed that following specific interventions, there were improvements in the student-coaches' ability to organize and present tasks to their teammates, to identify skill errors and provide feedback, as well as the ability to modify tasks for different team members. These findings complement earlier research with teachers which has found that increasing their CK (in particular, CCK and SCK) has a positive impact on their PCK (Iserbyt, Ward, and Li 2015; Iserbyt, Ward, and Martens 2016).

One noteworthy finding of this study is the value of having deliberate programmes of student-coach preparation. Indeed, it was found that when students were simply allocated to positions where were expected to lead their teams without training, these coaches implemented a number of instructional strategies that had the potential to jeopardize student learning. In contrast, when student-coaches' CK was supported through the implementation, analysis, and evaluation of protocols for improving their PCK, there was a subsequent improvement in their instructional quality.

Despite the fact that Sport Education is a student-centred approach (Dyson, Griffin, and Hastie 2004), the present study has shown that giving students complete autonomy is not a straightforward task. More so, student-coaches are better served with a gradual release of responsibility from the teacher to them. Pearson and Gallagher (1983) suggest that students (or in our case, student-coaches) are supported in their acquisition of the skills and strategies necessary for success. In this study, student-coaches progressed from situations in which the teacher took the majority of the instructional

responsibility (for instance, at the beginning of the first protocol), to situations in which they assumed all or nearly all the responsibility within the peer-assisted tasks (during the third season). During this gradual release of instructional responsibility, the strategies applied to aid improvements in student-coaches' CK and, consequently, PCK were in some ways quite distinctive.

In particular, given the student-coaches' difficulties encountered during the first season, it was necessary to provide them with sufficient CK during the second season. The teachers' modelling, in which he offered student-coaches 'behaviour for imitation' (Tharp and Gallimore 1988, 47), seemed to be important by providing them with a visual model of what was expected concerning the presentation and monitoring of the learning tasks. In addition, the pre-lesson meeting with the student-coaches allowed the teacher to deliver the CK regarding the tasks to be organized in the upcoming lesson. During these meetings, the teacher had time to explain the technical and tactical skills (namely critical components, most common errors, etc.) that would be taught during the lesson. These two pedagogical strategies implemented during the second season allowed improvements on student-coaches' SCK, CCK which had the potential to positively impact their PCK. That is, the student-coaches began to be aware of the organization of the tasks, they started to organize the tasks with their teammates, and started to diagnose errors and provide feedback in basic technical and tactical skills.

Furthermore, the teacher's modelling and the implementation of the coaches' corner allowed the 'direct maintenance' (Brophy 1999) of the content to be taught during the lesson. Given the initial student-coaches' difficulties with PCK, the only way to avoid limiting students' learning within the lesson was through a close intervention of the teacher. Moreover, the coaches' corner allowed the teacher to guide student-coaches' intervention during the lesson, without providing information to the entire class. This strategy allowed the teacher to check if student-coaches were making major errors (e.g. inappropriate organization of a task, lack of feedback, etc.). If the teacher did identify critical incidents, he was able to gather the student-coaches and provided them with appropriate feedback. This helped to promote the alignment of student learning with intended teacher learning goals.

Despite these improvements in the student-coaches' CCK and SCK, they still showed some difficulties within the peer-assisted tasks during the second season. The extracurricular meeting implemented during the third season was considered crucial to the improvement of the student-coaches' PCK. In particular, during the first phase of the unit, the student-coaches still struggled with aspects of CCK (particularly regarding the more complex tactical content) and SCK (e.g. identifying appropriate task modifications). The use of video recall reduced the reliance on the student-coaches' memory and allowed a greater range of behaviours to be analysed, a point already highlighted by Carson (2008). At the same time, consistent with the findings of Byra (1996), the video reviews also provided student-coaches with a greater depth and detailed analysis of their intervention.

The second phase of the protocol for this third season allowed the student-coaches to be more autonomous in organizing and monitoring the tasks, to be creative problem solvers, and to reflect on their own practices. Within these lessons, the teacher facilitated student construction of PCK by providing the student-coaches with the opportunity to discuss and debate with their peers. Through the use of videos from previous lessons, the teacher stimulated students' prior knowledge by asking questions, providing hints and allocated more time during the meetings for student-coaches suggestions. The student-coaches' improved ability to solve problems they encountered throughout the lesson hence became more evident during the later lessons of the third season. For example, during moments when students were not achieving the critical components of the tasks, the student-coaches were seen to modify tasks previously planned by the teacher, in order to focus teammates' attention on a specific tactical skill.

In moving the students through the flow chart presented in Figure 1, it is important to recognize the teacher's PCK. Having considerable expertise in volleyball, the PCK of this teacher was crucial to the evolution of student-coaches, as it allowed him to successfully model volleyball-specific content

as well as identify critical incidents in volleyball learning during the extracurricular meetings. Given that teachers' PCK is particularly critical during the use of the Sport Education model (Stran and Curtner-Smith 2010; Metzler 2011; Iserbyt, Ward, and Li 2015) and other game-based approaches (such as SGA in this study), it could be suggested that a scarce teachers' CK may limit their ability to assist student-coaches to design tasks, identify errors and provide appropriate feedback.

Although this study makes a contribution to the research on model-based practice, there are certain limitations that should be acknowledged. First, we are aware that the video-stimulated reflections applied during the last season may not be a realistic pedagogical protocol for most teachers to use in physical education lessons, due to potential constraint of time (e.g. the need to have extra-curricular meetings, and the time needed by the teacher to observe the videos and select appropriate samples). Nevertheless, this pedagogical strategy was crucial in promoting the student-coaches' observation skills as well as their ability to reflect on their own practices. One compromise might be the incorporation of mobile devices such as iPads which have been shown to be useful for in-class demonstrations of practical pedagogical strategies (Sinelnikov 2012).

The second limitation of the study is that only three students experienced the role of student-coaches. Nonetheless, this was necessary in order to analyse the evolution of these student-coaches' PCK throughout the time. The value of having this focused and extended examination is that we now have strategies that can be implemented from the beginning of seasons, without the need for the gathering of baseline data. That being said, a replication of the current study with a larger sample is certainly warranted. For instance, a larger scale study might investigate the performance of different coaches across different sports, but retaining those coaches in their same sport across repeated seasons.

Conclusion

The present study analysed student-coaches' development of PCK during peer-assisted tasks of Sport Education, and to examine the impact of specific protocols for the preparation of these students. Results showed the efficacy of these protocols, accompanied by a teacher with high levels of volleyball PCK, in promoting student-coaches' CK and, consequently, PCK. Nevertheless, the study also showed that this preparation does not occur immediately, and different strategies should be applied to take into account the phase of student-coaches' preparation. In the beginning of the preparation, it was important to provide, demonstrate and model student-coaches' CCK and SCK, while during the third season, the preparation moved towards challenging the student-coaches' ability to autonomously solve the problems they might face during practice.

Future research might focus on the direct link between the abilities of student-coaches and the subsequent players' competence in their teams. In particular, as aforementioned research on teachers' PCK has been showing the positive impact of increased PCK on students' performance in physical education. Notwithstanding, future research might focus on the effects of the improvement of student-coaches' PCK on students' performance and learning within Sport Education seasons. On a related track, research is also warranted concerning the role (and training) of the student-coach in achieving the social goals of Sport Education. In particular, future studies are encouraged to examine students' engagement and the dynamics operating within instructional models. In this way, it would be possible to obtain a more realistic portrait of the impact of these models, deeply understand the teaching–learning process by the identification of possible factors that might promote different learning opportunities and, consequently, guide future model-based research and practical implementations.

Disclosure statement

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