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Do Physical Education Teachers Use Socioconstructivist Communication Patterns in Their Classes?

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Purpose: This study aims to identify socioconstructivist communication patterns used by physical education teachers and their evolution after participating in a training intervention. **Method**: The authors analyzed 812 units (messages containing constructivist discursive strategies) employed by two physical education teachers in two teaching modules using observational methodology. The data were analyzed by polar coordinate analysis. **Results**: In the pretraining phase, Teacher 1 presents two discursive patterns with questions–answers–literal incorporation of student-answers into the teachers' communication, and another formed by praise questions. Teacher 2 generated praise-questions only. In the posttraining phase, Teacher 1 maintains one of the initial patterns and generates another consisting of questions-incorporation of students' actions into the teacher's communication. Teacher 2 incorporates two new patterns composed of information demands that are associated with the use of a specific frame of reference, or meta-statement. **Discussion**: The use of polar coordinate analysis revealed the presence of communication patterns and their evolution. **Conclusion**: The training intervention has resulted in changes in the communicative patterns of teachers. The custom-made instrument has allowed knowing the discursive strategies

Keywords: learning to teach, mixed methods, polar coordinates, social-constructivist theory, teacher communication

Constructivist pedagogies attach great importance to using previous knowledge and experiences as a framework for the construction of new knowledge and meanings (MacPhail, Tannehill, & Karp, 2013). Students create knowledge in relation to what they already know (Holt-Reynolds, 2000). The mediating role of instructional communication in the construction of shared meanings between teachers and students can be very relevant. Therefore, it is important to analyze what teachers and students say while interacting to better understand how learning in physical education (PE) is built and to optimize the process.

Teaching communication was conceived as an intentional and strategic act (Powell & Kalina, 2009) and constitutes a resource for cognitive mediation (Fernyhough, 2008). From a socioconstructivist perspective, teacher communication can fulfill three pedagogical functions through particular forms of language (Coll & Onrubia, 2001). The first, function of teacher communication is activation and exploration of prior knowledge, which alludes to the social or specific frame of reference and uses questions to generate spaces of intersubjectivity and a collective awareness of the learning object (Table 1; Example: Do you remember the 10-pass game we did the last day?). This function would challenge students to recognize previous learning (Brooks & Brooks, 1993). For a zone of proximal development to be created, actors must be prepared to enter a shared world of meanings (Roth & Lee, 2007). The zone of proximal development is the distance between the actual developmental level as determined by independent problem solving and the actual level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978, pp. 85–86). A second function generates a positive attitude toward ongoing learning by using meta-statements, incorporating the students' contributions to the teaching staff's instructional communication, or characterizing the knowledge as shared (Table 1). In the third function, students' knowledge is guided toward expert representations by reworking students' contributions; labeling certain aspects of the content; abbreviating expressions changing the referential perspective used to talk about the content and conducting recapitulations, summaries, and synthesis. These particular forms of language were named by Coll and Onrubia (2001) as discursive strategies which are a form of language highlighting its intentional and strategic use. In PE, from this theoretical approach, Barker, Quennerstedt, and Annerstedt (2015) point out that the student interactions can be oriented from the principles of the post-Vygotskian theory for more effective learning. These are based on the importance of the initial semiotic agreement as a prerequisite for learning, the complexity of expert–novice relationships, and knowledge and learning as a means of reaching agreement. Rink (2019) considers that the "instructional strategies" used in teaching PE (check for understanding, draw on personal experience of learners, connection to other topics, and recapitulations) are a methodological resource. Dina and Dina (2014) point out that PE learning is carried out through the motor behavior of students and is considered an element of communication.

Some authors analyzed communication strategies that improve effectiveness and motivation in PE sessions (Webster, 2010), such as being clear; content relevance; using humor (Chesebro & Wanzer, 2006); or relational issues, such as showing immediacy, manipulate presentation style, and listening. Webster, González, and Harvey (2012) analyze the frequency of its use based on the condition of expert or novice teachers and how students perceive motivation (Webster, Mindrila, & Weaver, 2011). The results showed that expert teachers make greater use of these communication strategies (content

Table 1   Observational Instrument (*Analysis of Educational Discourse in Physical Education*)

Dimensions (3)	Category systems (3) and definitions of categories	Example
Exploration and activation of previous knowledge	*Use of social framework (A1)*: References to social situations/events (or their meanings) related to the subject matter or task at hand with the aim of establishing sharing meanings in relation to these situations/events.	*You have to jump like a frog.*
	Use of specific framework (A2): References to specific previously shared learning experiences, clearly highlighting their relationship with the subject matter or task at hand, seeking to establish shared meanings.	*At the beginning of the course, we are moving from one point to another; today we are going to do sprints.*
	Request for information (A3): Use of strategies to obtain relevant information from the students on the subject matter or task at hand, but without mention of a social or specific framework.	*How many different ways did they throw the ball?*
Attribution of positive meaning by students	Use of meta-statements before the task (B1): References to what is going to be done (we are going to . . .) or to what might occur, without linking these to a previous activity, and only including messages that refer to the subsequent learning activity.	*We are going to play the 10-pass game so that the player who is about to receive the ball in movement learns to get free.*
	Use of meta-statements during the task (B2): References that remind students about the goal of the task, that is, about what it is they are trying to improve.	*We are practicing our aim and learning to move the cones.*
	Incorporation of students' contributions into the teacher's discourse (B3): Literal or near-literal incorporation into the teacher's discourse of elicited or spontaneous verbal contributions from the students about what they are learning.	*As Laura says, I have to move faster.*
	Incorporation of students' actions into the teacher's discourse (B4): Incorporation into the teacher's discourse of a specific aspect of a student's motor behavior, with specific reference to the student involved, with the aim of guiding learning.	*Did you see how Luis moves his feet when skipping?*
	Characterization of knowledge as something shared (B5): References to the subject matter or the task at hand, or their results, systematically using the first-person plural (we), and drawing attention to what has been learned or is about to be learned, with the inclusion of a positive evaluation.	*We have successfully kept the ball in the air.*
	Acknowledgment of acquired personal knowledge (B6): References to current tasks or their results using the second- or third-person singular or plural (you, he/she, they) and highlighting something that has been learned.	*Sandra, your shot was very good; you positioned your hands and feet just like we said you should earlier.*
	Praise for verbal contribution or action (B7): References to current activities or their results using the second- or third-person singular or plural (you, he/she, they) in response to a motor behavior or verbal comment by a student or group of students, but without mention of a specific type of learning.	*Very good! Nice! Perfect! Great! Excellent!*
Progressive establishment of increasingly expert and complex representations of subject matter	Re-elaboration of student contributions (C1): Re-elaboration of a spontaneous or elicited motor or verbal contribution from a student, where the teacher expands, develops, reorganizes, trims, or corrects the relevant information. Categorization and labeling of aspects of content or context (C2): Redefinition and characterization of a concept, contextual aspects, an activity, or its results; the teacher may do this spontaneously or use labels typically employed by the students.	*Michael says that if we throw the ball in the air, we push our bodies upward, and if we throw it in front of us, we push our bodies forward. The leg in front is called the drive leg.*
	Introduction of different referential perspective (C3): Introduction of new referents (spatial, temporal, tactical–strategic, biomechanic–technical, and/or physical–physiological) in relation to the task the students are about to start, or to an object or concept. The task/object/concept is clearly identified and highlighted.	*When running in a hurdle race, it is not a good idea to jump over the hurdle when you are very close to it, as we can hurt ourselves. We are going to try to do it at a fast pace, with our front leg in a semi-bent position.*
	Cognitive transfer of learning to a future situation (C4): Description and/or justification of how the object of the lesion or task can be applied in a future situation.	*We are going to work on our spatial–temporal perception, and this will help us to know whether we can cross the road safely or not when we see a car coming.*

relevance) that promote students to continue learning. From a qualitative perspective of analysis, Valley and Graber (2017) showed that teachers, who do not use an intentionally inclusive language, reinforce gender stereotypes. In addition, they point out inclusive communication can be an effective agent to increase expectations on the *abilities to perform physical skills* for females and lower skilled males in PE. This last experience highlights the importance of endowing teacher communication with a pedagogical intention. The studies of García-Fariña, Jiménez Jiménez & Anguera (2016, 2018) reveal patterns allow us to get closer to the knowledge of regular structures of teacher communication in PE.

From the socioconstructivist perspective, the teachers value the contributions of the students by involving them in the construction of knowledge and by connecting the students' experiences with PE

(Azzarito & Ennis, 2003). The general principles of this theory (higher mental processes, language, mediation, cultural influence, and zone of proximal development) have application in PE because it is a discipline that promotes the development of motor competence and higher mental processes, allowing the exploration of concepts through action and language (Ussher & Gibbes, 2002). Rovegno and Dolly (2006) and Ussher and Gibbes (2002) attribute a constructivist basis to various models of teaching sports: Teaching Games for Understanding (Bunker & Thorpe, 1982; Kirk & MacPhail, 2002; Oslin & Mitchell, 2006), Sport Education, Personal and Social Responsibility (Hellison, 2011; Hellison & Walsh, 2002), and Adventure-Based Learning (Sutherland, Stuhr, & Ayvazo, 2016). In these models, the teacher–student dialogic activity about an action aimed at solving problems has special relevance, and asking questions is part of the intraclass communication sequence with the aim of promoting reflection and understanding in students. This creates a learning environment that involves students in the construction of knowledge (Harvey & Light, 2015) and helps them learn to learn (Light, 2014). To encourage critical thinking and problem solving (Dyson, Griffin, & Hastie, 2004; Hubball, Lambert, & Hayes, 2007; Mitchell, Oslin, & Griffin, 2006), questions must be prepared and planned in advance. Powell and Kalina (2009) and Rosenshine (2012) believe the development of an effective class requires a teacher who asks questions that help students connect new information to their prior learning. The importance of planning an educational interaction that facilitates the construction of knowledge is also highlighted by MacPhail et al. (2013) through the concept of "constructive alignment," which refers to the internal coherence between objectives, evaluation, teaching strategies, and learning activities.

From a socioconstructivist perspective, communication patterns may enhance teacher communication as a resource that helps students learn.

This invites us to question PE teachers about the training strategies that will be used. The objectives of this study have been: (a) to find out if PE teachers use socioconstructivist communication patterns in their class and (b) to know the effect of a specific training process on the evolution of these communication patterns.

Method

Design

Observational methodology is an appropriate method for studying PE (Kluwe, Miyahara, & Heveldt, 2012; Lhuisset & Margnes, 2015) from the motor (Anguera et al., 2017) and communication (Anguera & Izquierdo, 2006) perspectives because it offers flexibility and accuracy. The observational design (Anguera et. al, 2011) applied in this study was nomothetic/follow-up/multidimensional (N/F/M) for the following reasons: (a) nomothetic means that there are several participants, and we analyze the discourse of two teachers; (b) follow-up because we analyzed two teaching modules (TMs): several sessions with intersessional follow-up and intrasessional follow-up (from the beginning to the end of each session); and (c) multidimensional because verbal behavior was unfolded into three dimensions, guided by theoretical framework to provide a greater depth of analysis.

We consider that indirect observation (Anguera, 2020, in press; Anguera et al., 2018), which involves the analysis of textual material generated either indirectly from transcriptions of audio or video recordings of verbal behavior in natural settings or directly from narratives, provides the sufficient and necessary methodological rigor to be used in a mixed methods study, such as ours.

First, indirect observation is characterized by partial perceptivity (Anguera et al., 2018) because the verbal behavior nature may involve a risk of subjectivity when coding; and therefore, precautions are taken to have a greater methodological guarantee (basically in the control of data quality). Second, observation, or indirect observation as in our case, can be considered a *mixed method* methodology. As we have argued in previous works (Anguera et al., 2017; Anguera & Hernández-Mendo, 2016), observational methodology—and indirect observation—could be considered as *mixed methods*. We start with the notion established by Creswell and Plano Clark (2007, p. 7) regarding the *connecting* option, which is "connecting two datasets by having one build on the other." Taken both literally and from a broader perspective, it involves the systematization of initial descriptive records—first qualitative data set—through a specific observation instrument (mainly a field format combined with category systems (see *Analysis of Educational Discourse in Physical Education* and Table 1) to obtain an equivalent code matrix, which remains qualitative that will be analyzed through specific quantitative techniques for categorical data (in this current study, polar coordinate analysis). In addition, the connecting option (Creswell & Plano Clark, 2007) allows the alternation of QUAL-QUAN-QUAL stages, which is consistent with the generic approach of the *mixed methods*, while achieving a total integration between qualitative and quantitative elements (Anguera et al., 2020).

Participants

The participants were two primary school PE teachers who were selected using an intentional nonprobabilistic sampling criterion (Anguera, 2003). Teacher 1 had 9 years' experience teaching fifth grade, and Teacher 2 had 2 years' experience teaching sixth grade. Both attended their initial training in the same university center and gave two sessions each week of 45 min in public primary education centers. Two TMs were analyzed for each teacher: one before a specific training process and another at the end of the training process.

There were were 39 students (17 boys and 22 girls) who participated. The mean age was 10.7 years. The students were from two different schools and from two different grades: fifth grade (19 students) and sixth grade (20 students). The teaching staff selected students according to criteria for accessibility. Students came from courses in which they taught and were approximately the same age, and belonged to the same educational cycle (third cycle of primary education). Establishing exclusion criteria was unnecessary because all students met the selection criteria.

This study was carried out in accordance with the recommendations of the ethical committee of the University of La Laguna (Spain) with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

Instruments

We developed *Analysis of Educational Discourse in Physical Education* (Anguera et al., 2007; Morgan, Sproule, Weigand, & Carpenter, 2005) to identify and record the different discursive strategies employed by the two teachers. This instrument is a field format system which consists of three category systems, built from the dimensions of discursive strategies proposed by Coll and Onrubia (2001) and the situational context: (a) exploration and activation of previous knowledge, (b) attribution of positive meaning by students, and (c) progressive establishment of increasingly

expert and complex representations of subject matter. These three dimensions, in turn, comprised three, seven, and four categories, respectively (Table 1).

Once the instrument was configured, a content validation was carried out by three experts in sports science research methodology. For the analysis of the inter- and intraobserver reliability and validity of the instrument, the Generalizability Theory (Blanco-Villaseñor et al., 2014; Brennan, 2003; Cronbach et al., 1972) was used. To do this, a TM composed of five sessions was analyzed. Two sessions were chosen at random. Each contained a 15-min video. The records were made by two observers at two different times that were separated by 15 days. The absolute and relative generalizability coefficients for the facets: observer, criteria, and categories were greater than 0.95.

The recording instrument was a Panasonic HCD-HS100 video camera (Hamburg, Germany) and a wireless audio system (APKPR40 + PT40, Stamford, Connecticut). Each session was recorded from beginning to end. The data were recorded by three observers using the Atlas.ti 7 (Cologne, Germany) program. The observers were trained for over 80 hr over a 6-month period.

The quality of the resulting data sets was checked by analyzing intraobserver agreement using Krippendorff's canonical agreement coefficient (Krippendorff, 2013), which is an adaptation of Cohen's statistic (Cohen, 1960) designed for use with more than two data sets collected at different moments. The analysis was performed using HOISAN 1.6.3 (University of Málaga, Spain; Hernández-Mendo, López-López, Castellano, Morales, & Pastrana, 2012). The vector graphing has been done using the R program (Rodríguez-Medina et al., 2019). For this analysis, the three observers recoded 15 randomly selected minutes of content, on three occasions, separated by 10 days each. The resulting agreement coefficient was 0.97. The qualitative interobserver consensus agreement method was also applied (Arana et al., 2016), registering the three observers using this procedure, 15% of the total of the 18 recorded sessions.

Procedure

The data were collected by recording 18 PE sessions with Teacher 1, five sessions of a first TM before the specific training and four sessions in a second TM posttraining phase. For Teacher 2, there are four sessions in the TM before the specific training, and five sessions after the training process. The training specifics consisted of a collaborative research–action program (Pérez-Van-Leenden, 2019) with a duration of 16 weeks (eight biweekly sessions) in which two teachers participated and A.G.-F. served as the coordinator. The four moments of the research–action were as follows: planning, action, observation, and reflection (Carr & Kemmis, 1986). In the first three sessions, basic concepts were discussed: teacher communication in PE, socioconstructivism, and discursive strategies to access previous knowledge. In the fourth and fifth sessions , the discursive strategies at the service of the positive attribution of ongoing learning were identified and the following question was asked: How to progressively apply the discursive strategies in PE? During the final sessions, discursive strategies were identified, and a self-evaluation of the discursive resources used in the teaching intervention was completed to assessing the effects generated by the students.

Following the indirect observation procedure method (Anguera, 2020, in press; Anguera et al., 2018; Morales-Sánchez et al., 2014), the recordings of the analyzed sessions were transcribed and segmented into textual units (Krippendorff, 2013), which were then coded using the *Analysis of Educational Discourse in Physical Education* to produce a matrix of codes (Table 1). A total of 812

messages containing the discursive strategies analyzed were recorded. The columns of this matrix corresponded to the three dimensions, while the rows corresponded to each of the textual units generated during the text segmentation process. Next, the content of the messages in the teachers' discourse was segmented using qualitative syntactic criteria, dictated by the definitions established (Table 1) (Gordo & Serrano, 2008; Krippendorff, 2013). Adequate text segmentation implies a degree of systematization, and facilitates subsequent data quality control and quantitative analysis.

Data Analysis: Polar Coordinate Analysis

The analysis of polar coordinates was proposed by Sackett (1980). An observational record showed the interrelationships between a category of the observation instrument, called focal behavior, and other categories of the observation instrument, called conditioned behaviors. By placing ourselves within the framework of the mixed methods, the starting point is a qualitative record (see fragment of discourse in the "Results" section), which has been systematized by the observation instrument obtaining a matrix of codes; it is here where the quantitative analysis is performed (Anguera et al., in press; Aragón et al., 2017; Castañer et al., 2017; Maneiro, Amatria, & Anguera, 2019).

Polar coordinate analysis is the second part of a lag sequential analysis (Bakeman, 1978), which must be performed previously. In this previous analysis, it is required that the registration carried out be sequential (in this study, succession of sentences of the discourse), and from this ordered information of the record, conditioned probabilities are calculated (which depend on the order of the registered data and take as starting the same category that will interest us as focal behavior) and unconditional probabilities (which depend on the frequency of occurrence of the categories corresponding to the conditioned behaviors, and indicate the effect of chance). A binomial test is applied to perform the contrast between these probabilities, and adjusted residues are obtained, which are the results of the lag sequential analysis.

These adjusted residuals are the data for the polar coordinate analysis that is carried out below and that will require the calculation of the parameter Z_{sum}, proposed by Cochran (1954), which quantitatively gives us the value of the relationship intensity between the focal behavior and each conditioned behavior from a prospective approach (from the occurrence of the focal behavior forward) and from a retrospective approach (behaviors recorded before each occurrence of the focal behavior).

These prospective and retrospective Z_{sum} values (see Tables 2 and 3) allow us to calculate the length and angle of the vectors (Sackett, 1980). Each vector shows the interrelation between the focal behavior and a conditioned behavior, which according to the quadrant in which it is found (see Table 4) has a certain interpretation. Also, the vector is significant if its length is >1.96 ($p < .05$).

Results

The polar coordinate analysis was performed using information demand (A3) as the focal category with the different conditioned categories. Below is the behavioral map estimated from focal category A3 for Teacher 1 before and after participation in the collaborative research–action program (pre- and posttraining). Results show that the focal behavior A3 (Table 2 and Figure 1) has significant ($p < .05$) communication patterns before and after the training program. One of the patterns appears in Quadrant I, which shows mutual (and asymmetric) activation between request for information (A3) and incorporation of student's contributions

Table 2 Polar coordinate Analysis Results of Teacher 1 for Focal Behavior (A3, Request for information)

Conditioned behavior	Quadrant		Z_{sum} prospective		Z_{sum} retrospective		Radius		Angle	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
A1	I	II	0.31	−1.43	−0.01	0.51	0.31	1.52	358.75	160.46
A2	I	II	−0.96	−0.63	−1.11	0.87	1.47	1.08	229.05	125.75
B1	I	II	0.53	−0.64	1.33	1.83	1.43	1.94	68.22	109.32
B2	II	II	−0.23	−0.2	0.56	0.22	0.61	0.3	111.87	131.5
B3	I	IV	5.71	2.98	2.46	−1.86	6.21*	3.52*	23.32	328.07
B4	III	I	0	1.97	0	2.18	0	2.94*	NeuN	47.79
B5	IV	I	0	1.04	0	1.05	0	1.48	NeuN	45.42
B6	IV	II	0.69	−2.32	0.98	1.68	1.2	2.87*	54.78	144.04
B7	III	III	−7.4	−2.56	−4.7	−2.12	8.77*	3.32*	212.43	219.55
C1	I	IV	1.79	0.04	0.26	−0.19	1.81	0.19	8.29	281.39
C2	I	II	0	−1.89	0	0.17	0	1.89	NeuN	174.79
C3	II	IV	0	1.46	0	−0.87	0	1.71	NeuN	329.2
C4	II	IV	1.28	0.54	−0.95	−1.73	1.59	1.81	323.35	287.32

Note. The transitions of the prospective and retrospective Z_{sum} categories and values, quadrant of the vector, length of the radius, and angle of the vector are also presented. For both the pre- and postsituations, the quadrant in which the vector is located, the prospective and retrospective Z_{sum} values, the radius or length of the vector, and the angle are presented for each conditioned behavior.
*Significant vectors (radius > 1.96).

Table 3 Polar coordinate Analysis Results of Teacher 2 for Focal Behavior (A3, Request for information)

Conditioned behavior	Quadrant		Z_{sum} prospective		Z_{sum} retrospective		Radius		Angle	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
A1	IV	IV	0.53	0	−1.25	0	1.35	0	292.99	NeuN
A2	IV	I	0.47	0.14	−0.98	2	1.08	2*	295.47	85.99
B1	IV	I	0	0.14	0	2.63	0	2.64*	NeuN	86.95
B2	IV	IV	0	0	0	0	0	0	NeuN	NeuN
B3	III	I	−0.77	0.22	−2.66	0.17	2.77*	0.28	253.89	37.04
B4	IV	IV	0	0	0	0	0	0	NeuN	NeuN
B5	IV	IV	0	0	0	0	0	0	NeuN	NeuN
B6	IV	IV	0	0	0	0	0	0	NeuN	NeuN
B7	II	III	−0.27	−0.34	2.83	−1.06	2.84*	1.11	95.42	252.11
C1	III	III	−0.91	−0.2	−0.57	−0.57	1.07	0.61	212.09	250.71
C2	II	II	−0.58	−1.32	0.71	0.02	0.92	1.32	129.24	179.19
C3	IV	IV	0	0.14	0	−1.17	0	1.18	NeuN	276.83
C4	IV	IV	0	0	0	0	0	0	NeuN	NeuN

Note. The transitions of the prospective and retrospective Z_{sum} categories and values, quadrant of the vector, length of the radius, and angle of the vector are also presented.
*Significant vectors (radius > 1.96).

Table 4 Guide for the Interpretation of the Results in the Analysis of Polar Coordinates Depending on the Quadrant in Which the Vector is Located

| Quadrant	Prospective Z_{sum} sign	Retrospective Z_{sum} sign	Interpretation
I	+	+	Focal and conditioned behaviors activate each other
II	−	+	Focal behavior inhibits the conditioned one; and conditioned behavior actives the focal
III	−	−	Focal and conditioned behaviors inhibit each other
IV	+	−	Focal behavior activates the conditioned one; and conditioned behavior inhibits the focal

P1 pretraining

P1 posttraining
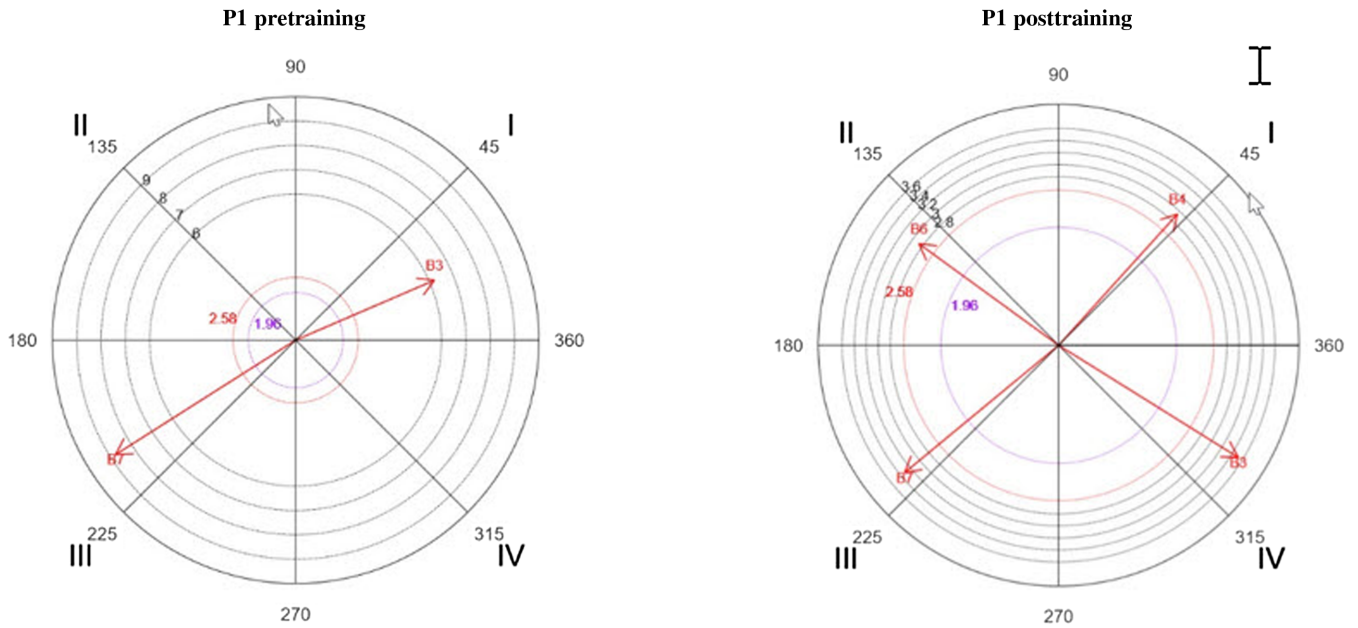
Figure 1 — Vectors map for Teacher 1 showing the relationships between the focal behavior (A3, request for information) and the conditioned behaviors (other discursive strategies).
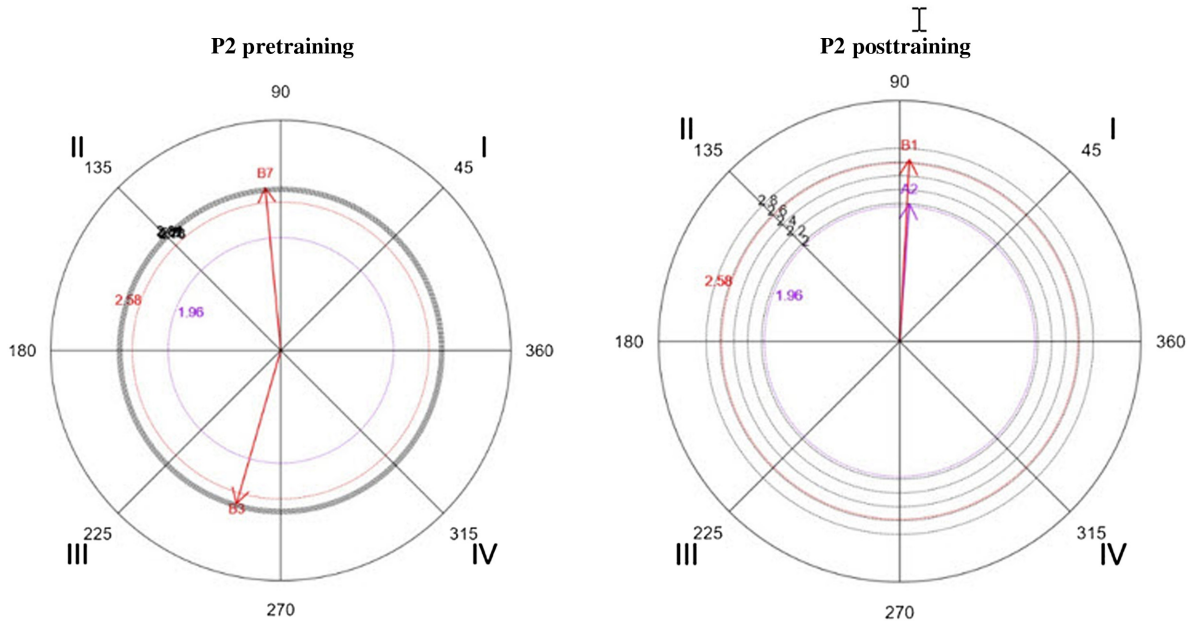
P2 pretraining

P2 posttraining

Figure 2 — Vectors map for Teacher 2 showing the relationships between the focal behavior (A3, request for information) and the conditioned behaviors (other discursive strategies).

into the teacher's discourse (B3), which indicates that asking questions stimulates the incorporation of students' contributions into the teacher's discourse.

> *Teacher:* Sandra, tell me one way of warming up (A3)
> *Student:* Heels back.
> *Teacher:* Heels back (B3).

In Quadrant III, Categories B7 (praise) and A3 are mutually inhibited, with the vector showing that praise and request for

information do not occur successively and are probably not directly related (Table 2).

In the posttraining phase, we observed that the first pattern was kept and a new pattern was generated. Quadrant I shows the discursive Strategy B4, which activates and generates the pattern of A3 and B4.

> *Teacher:* How is Luis moving his feet?
> *Student:* Like this

Teacher: He moves them at the same time to jump the rope (B4).

The transitions of the prospective and retrospective Z_{sum} categories and values, quadrant of the vector, length of the radius, and angle of the vector are also presented.

In the case of Teacher 2 (Table 3 and Figure 2), Quadrant II (prospective inhibition and retrospective activation) shows how in the pretraining phase praise B7 activated (but did not inhibit) the use of questions, forming a pattern, and indicating that praise by the teacher was followed by requests for information A3.

Teacher: Very well Miguel (B7). Now how do we put our hands? (A3)

However, in Quadrant III, Category A3 appears, indicating that they are inhibited and that there is no direct relationship between the two. In the posttraining phase, however, the analysis revealed mutual activation between A3 and A2 (reference to a specific framework).

Teacher: Do you remember what we did on the last day of class? (A3).

Student: Yes

Teacher: The last day we were doing displacements, today we will do speed races (A2).

And also, with B1 (use of metastatements).

Teacher: Do you know the game of the 10 passes? (A3)

Student: No

Teacher: The game of the 10 passes is done so that the player who receives while moving learns to get away from rival players (B1).

This suggests that during the class, the teacher asked questions, commented on whether the task had already been performed, referred to the purpose of the task.

Discussion

The use of polar coordinates in this study is justified by the interest in knowing if the instructional communication of the teachers obeys discursive patterns and if these evolve after participating in a research–action program. To achieve the desired objective, the demand for information or questions (A3) and the rest of the discursive strategies were taken as focal behavior. We applied the *Analysis of Educational Discourse in Physical Education* that contains as criteria the three great pedagogical functionalities of teacher communication (Coll & Onrubia, 2001).

In the pretraining phase, the Teacher 1 generates a powerful communicative pattern, consisting of A3 + B3 (question–answer–literal incorporation of student contributions; $p < .05$), with characteristics similar to the IRE discourse pattern that has already been detected in other studies (Lobato, Clarke, & Ellis, 2005). This is one of the resources of constructivist approaches, since it fosters a positive learning environment, dialogue, and the construction of shared meanings (MacPhail et al., 2013). According to Harvey and Light (2015), asking questions will not necessarily contribute to the application of constructivist-based models, such as Teaching Games for Understanding (Dyson et al., 2004; Hubball et al., 2007; Mitchell et al., 2006), but it is necessary to stimulate thought, social interaction, and promote the metacognition of students.

Both teachers in the pretraining phase generate a communication sequence formed by the dyad of the two categories B7 + A3 (Quadrant II), using praise when information is required from the students. This type of teacher communication improves the motivational climate (Webster et al., 2011, 2012).

In the posttraining phase, Teacher 1 generates a new sequence of communication appears consisting of A3 + B4 (incorporation of the actions taken by the teacher), which denotes that the teacher has discourse aimed at considering what the students do motorically (Dina & Dina, 2014). However, we found in Quadrant III, a strong inhibition with praise (B7); that is, there is no case where there is a question and the answer is praised. This demonstrates the teacher prefers this strategy for moments or situations in games or tasks that require positive feedback.

Teacher 2 generates two new communication patterns. The first consists of questions (A3) and then meta-statements (B1). We believe that the teacher has been interested in improving their communication by generating cognitive involvement regarding ongoing learning. The other dyadic sequence in the discourse is characterized by two discursive strategies that are aimed at exploring previous knowledge (A3 + A2). When the teacher asks, it allows connecting new situations with those already known (Azzarito & Ennis, 2003; Rosenshine, 2012).

The difference in the appearance of patterns before and after the training process is located in the intentional and strategic character of the employees after the training phase. This may explain the difference in the patterns of this second phase and those detected before the training process. On the other hand, the increase (Teacher 2), and the diversification (Teachers 1 and 2) of the communicative patterns show that the training phase, has allowed for them to be aware of the theoretical significance of the discursive strategies that they employ (MacPhail et al., 2013; Powell & Kalina, 2009; Rink, 2019). The demand for information (A3) has been part of the communication patterns of the two teachers before and during the posttraining stage, coinciding with one of the principles of instruction postulated by Rosenshine (2012), about how the questions allow a teacher to determine how well the contents have been learned and whether there is a need for additional instruction.

The teacher perceives advantages over the intentional use of instructional communication (Valley & Graber, 2017) because she finds that it offers greater possibilities to promote better learning for her students. The sequences detected are showing that teachers give preference to exploring the prior knowledge of students and reinforcing their correct answers, rather than evolving this knowledge into more expert ways, except for the re-elaborations of the contributions of the students who are added to the communication of the teacher which are increased in the postphase. This final aspect may be linked to the short duration of the didactic units analyzed and the young age of the students. Therefore, as our results confirm, participation in a research–action program can bring about positive changes in practice, reflected by the differences detected in the communication patterns before and after the program. The results of this study and previous ones (García-Fariña, Jiménez Jiménez & Anguera, 2016, 2018), invite us to reflect on the functionality of the differents discursive strategies analyzed. These should be intentional and strategic (Valley & Graber, 2017), discriminating what strategy to use, and when to use it (Coll & Onrubia, 2001). For this, teachers need to interpret the discursive strategies as a methodological resource that supports their teaching intervention (Rink, 2019), and consider them in their constructive alignment (MacPhail et al., 2013). The results of this study suggest the value and quality of the teaching methods employed by PE teachers as well as on the functionality of their discursive strategies.

Conclusion

The *Analysis of Educational Discourse in Physical Education* was developed for this study to analyze social constructivist discursive

strategies in a classroom setting and is a new methodological tool for analyzing teacher-led discourse in PE settings.

The research–action program caused the appearance of different discursive patterns in both teachers in the posttraining phase, being present in them, and the demand for information linked to various discursive strategies.

The previous observations clearly suggest that participation in this program led teachers to enrich their discursive resources by taking a more constructivist approach.

The methodology employed in this study revealed communication patterns in teacher-led discourse from a social constructivist perspective.

The use of polar coordinate analysis revealed the presence of communication patterns and their evolution. Participation in a collaborative research–action process has resulted in changes in the communication patterns of teachers. This knowledge allows PE teachers to improve their instructional communication.

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