Challenge-based learning approach to teach sports: Exploring perceptions of teaching styles and motivational experiences among student teachers

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ABSTRACT

The present study analyses how experiencing challenge-based learning (CBL) may affect student teachers' basic psychological needs and the perceptions of their teachers' styles in comparison with being involved in a traditional teaching (TT) methodology. A quasi-experimental study with experimental and control groups was carried out. A total of 128 responses ($n_{control}$ = 71; $n_{experimental}$ = 57) were reported by 83 student teachers from the Physical Activity and Sport Sciences Degree (M_{age} = 20.07, SD = 1.82; range = 17–27 years) who completed some self-reported validated questionnaires. Analyses based on non-parametric test to compare independent and related groups showed that, after the 14-week intervention, student teachers in the CBL condition exhibited higher competence satisfaction (M_{CBL} = 4.21 vs. M_{TT} = 3.80) and lower competence (M_{CBL} = 1.87 vs. M_{TT} = 2.46) and relatedness (M_{CBL} = 1.58 vs. M_{TT} = 1.99) frustration than the TT group. As for teaching styles, student teachers in the CBL-based experience perceived their professors as using more strategies supportive of autonomy and structure than student teachers in the TT group. The results of the study outline that CBL might be a valid methodological approach for student teachers to achieve motivational consequences in university context and in their future as teachers.

1. Introduction

Under the lens of self-determination theory (Deci & Ryan, 1985), an important research line has focused on the mechanisms explaining how teacher-student interactions affect several behaviours. This macro theory proposes that behavioural regulation in relation to an activity can vary according to the degree of self-determination, from intrinsic motivation to demotivation, intrinsic motivation being the most closely linked with adaptive behavioural outcomes, and demotivation understood as a lack of interest to engage in a certain behaviour. Self-determination theory proposes that people have three innate basic psychological needs, namely autonomy, relatedness and competence, which are associated with this self-determined form of motivation. In physical activity-related educational contexts, autonomy is associated with the feeling of freedom to make decisions during the performance and to express

one's own sentiments and opinions. Competence refers to the perception of feeling capable of facing the proposed activities and, thus, to a feeling of achievement. Relatedness refers to feelings of belonging to the group (Ryan & Deci, 2000; Vansteenkiste et al., 2020).

In a physical activity-related educational context, teachers can support autonomy by showing interest in students' feelings and preferences, offering them a relevant space for decision-making, or fostering a climate in which students can freely express their sentiments (Reeve & Cheon, 2021). Secondly, teachers can support their students' competence in the classroom through the provision of structure both before the activity—for instance, by setting clear expectations or adapting tasks to the students' level of skill—and during the activity, such as by providing effective feedback and thus guiding the learning process (Cheon et al., 2020). Lastly, relatedness support is characterized by the creation of warm contexts where teachers are empathetic, caring, and understanding of their students (Xiang et al., 2017). It seems to be widely accepted that teacher adoption of need supportive practices favours a range of adaptive students' outcomes such as learning and engagement (Aelterman et al., 2019; González-Peño et al., 2021; Moè et al., 2022; Moè & Katz, 2021).

Although basic psychological needs satisfaction has been more thoroughly studied, highlighting the importance of their fulfilling to enhance motivation (Zamarripa et al., 2021), Ryan and Deci (2000) proposed that the thwarting of basic psychological needs will lead to non-optimal development and ill health. Basic psychological needs frustration is thought to occur when individuals perceive their psychological needs to be actively undermined in their close social environment (Vansteenkiste et al., 2020). When displaying need-thwarting behaviours, teachers exercise power as an authority by ignoring students' perspectives or interests, demanding respect, or pressuring students by referring to their self-confidence (Soenens et al., 2012). It has been suggested that reducing these controlling behaviours will foster more adaptive outcomes between students (Abós et al., 2021). In this line, a recent study has proposed a classification system to identify different teachers' motivational behaviours consistent with SDT (Ahmadi, 2022). In this study, teachers' behaviours have been organized by psychological needs, and by how they affect them (whether supporting or threaten needs satisfaction).

1.1. *Understanding teaching behaviours under the lens of the circumplex approach*

Recently, an innovative approach has been developed to enhance understanding of the interactions between teachers and students through the analysis of teaching behaviours (Aelterman et al., 2019; Delrue et al., 2019). As shown in Fig. 1, the model distinguishes four different dimensions located around the vertical (level of directiveness) and horizontal axes (level of needs support provided). It must be noted that this approach does not consider the satisfaction or frustration of each need independently (as described in the previous section), but it rather establishes the horizontal axe as a measure of an overall need support. When displaying needs support behaviours and low directiveness, teachers are using an autonomy-supportive teaching style; conversely, when teachers show needs support behaviours and high directiveness, they are relying on a structured teaching style. On the other hand, when displaying needs-thwarting behaviours and high directiveness, they are implementing a controlling teaching style; but when teachers display needs-thwarting behaviours and low directiveness, teachers are displaying a chaotic teaching style (see Table 1 in supplementary material for a description of each style).

Within the autonomy-support dimension, teachers can adopt participative strategies, such as identifying students' personal interests and offering choice, or attuning strategies by looking for ways to make activities more interesting and enjoyable, both trying to identify and nurture students' personal interests. Related to structure, teachers can make use of guiding practices by, for instance, suggesting individual progressions to help the students to complete the task, or clarifying strategies such as being transparent and clear when communicating expectations from the lesson. A controlling teaching style is characterized by demanding strategies, such as the use of powerful and commanding language to require discipline, trying to change students' thoughts, and domineering strategies by which teachers induce feelings of guilt and shame, trying to make the students comply with their requests. In a chaotic style, teachers can make use of abandoning strategies such as leaving students on their own, giving up on them, or awaiting strategies, according to which teachers do not plan the lesson and tend to create a context where students have to take the initiative.
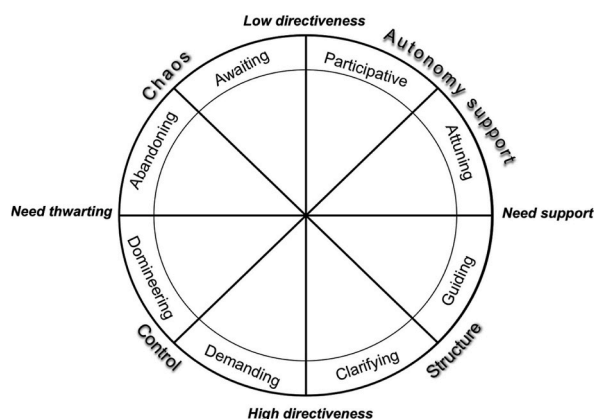

Fig. 1. Representation of the circumplex model (Aelterman et al., 2019).

Table 1
Association between CBL features and circumplex dimensions.

Challenge-based learning features	Dimensions of teaching style
Intervention phases: The course is organized following the familiarization, progression, and achievement phases	Structure
Lesson structure: Lessons are structured around the proposal of different-level challenges clearly established at the beginning	Structure
Individualization: There are different level challenges	Autonomy support and Structure
Tasks presentation: Challenges are presented with the support of graphical resources (images, videos). All challenges are available from the beginning	Structure
Students' autonomy support: Students can choose the challenges they want to tackle according to their own perceived competence	Autonomy support
Teacher's role: Since the challenges are presented to students through visual resources (videos, pictures …) teachers are free to better support and give feedback to the students during the practice	Structure
Students' involvement in their evaluation: Students take part in their evaluation since they can monitor their performance through the achievement of different challenges. Self-assessment sheets are provided	Autonomy support and Structure
Collaborative work: Some of the challenges can only be achieved by collaboration among students	Autonomy support and Structure
Students' proposals: Students design a CBL-based PE session	Autonomy support

The circumplex structure offers (see Fig. 1) a gradual view of teaching styles rather than a black or white approach (Delrue et al., 2019). It highlights the important role that teaching styles play in students' experiences (Escriva-Boulley et al., 2021), as well as the importance that education programs have on the development of teachers' skills to optimize their own motivation (Hortigüela-Alcalá et al., 2021) and create learning environments that enhance students' motivation (Xie et al., 2021).

Even though dozens of researchers have addressed the study of motivational processes in physical activity-related educational contexts, most of the studies have been developed in the secondary context. However, studies aiming to explore motivational outcomes among student teachers are less abundant, and research on basic psychological needs frustration in these contexts particularly so (Amoura et al., 2015). Researchers have reported that when student teachers perceive their professors as autonomy-, structure- and relatedness-supportive, their levels of autonomous motivation increase; they feel more competent and show less anxiety for the subject (Leenknecht et al., 2017). The study carried out by Vermote et al. (2020) was the first to apply the circumplex approach in analysis of the university context. The findings of their work, based on professors' perceptions, suggest that autonomous motivation and a growth mindset are likely to be linked with the use of motivating teaching styles. However, despite the expected discrepancy between teachers' and students' perceptions (Aelterman et al., 2019), there is no existing knowledge of student teachers' perceptions of their professors' styles from a circumplex perspective.

1.2. The association between methodological approaches and students' motivation

Extant literature shows that; besides teaching styles, methodological approaches can affect motivational processes among students (Bessa et al., 2021). Within physical activity-related educational contexts, certain specific methodological approaches such as the Sport Education Model (SEM; Manninen & Campbell, 2021), hybridization of the SEM and Teaching Games for Understanding (TGfU; Gil-Arias et al., 2018), or practice and inclusion teaching styles (Kirby et al., 2015) seem to be successful in the creation of motivational contexts. These studies highlight the important role that methodological approaches play in students' motivation, especially with low-motivation profiles (Franco, Coterón, et al., 2020), which in turn, could help to achieve greater student involvement and adherence to sports practice (Franco & Coterón, 2017).

1.3. Challenge-based learning in higher education

Challenge-based learning (CBL) is a learning framework which has been described in multiple ways (Gallagher & Savage, 2020). According to Nichols et al. (2016), it is a learning methodology that consists of posing a challenge as a didactic element, thus promoting the learning of knowledge together with enriching, attractive, motivating and meaningful experiences for students. In CBL, it is important to give autonomy progressively to the student, and it is necessary to propose stimulating contents that are focused on both the product and the process of learning. The teacher must act as a guide, expert, stimulator and supporter of the learner, whose particular characteristics must be considered when specifying and defining learning objectives. As for the learning content, it should provide students with the opportunity to interact with one another. This educational framework has been investigated in different disciplines, with an increasing emphasis in the fields of engineering and medicine but few studies in the field of physical activity (Gallagher & Savage, 2020).

Franco, Martínez-Majolero, et al. (2020) developed a proposal for the implementation of CBL within physical activity-related educational contexts. According to this proposal, adaptation of the complexity of the challenges to the students, design of well-structured activities, encouragement of cooperation among students and establishment of appropriate evaluation methods could be key elements for the successful implementation of CBL in the aforementioned contexts (Franco, Martínez-Majolero, et al., 2020).

Following Nichols et al. (2016) learning framework, in which three different phases—engage, research and act—are identified in the learning process (Franco, Martínez-Majolero, et al., 2020), proposed a methodological approach for physical activity-related educational contexts, also consisting of three phases:

- Phase 1: Familiarization. The teacher introduces the activity and in this way the pupil comes into contact with the sport through discovery.
- Phase 2: Progression. Mini challenges are carried out. In this phase, the student develops sport-specific skills.
- Phase 3: Achievement. Performance of a final demonstration of the skills acquired according to the level of difficulty achieved in the mini challenges. In this phase, the aim is execution of the sport.

The differential elements of the CBL according to the proposal by Franco, Coterón, et al. (2020) concern the intervention phases, the lesson structure, the implementation of individualization, specific features in task presentation, the provision of students' autonomy support, the students' involvement in their own evaluation, the presence of collaborative work and the nature of the proposals designed by students (see supplementary material, Table 2).

When analysing these features in detail, it can be perceived how some of them reflect characteristics of the circumplex model-based teaching styles according to the descriptions provided by Aelterman et al. (2019). Table 1 presented each of CBL feature that could be potentially related to the four main dimensions (autonomy support, structure, control, and chaos) established by circumplex approach. More specifically, it can be thought that when implementing CBL teachers might adopt a structured teaching style. Features such the existence of standardized intervention phases, the proposal of different-level challenges easy to adapt to different-level students, or the use of visual support could foster that teachers implementing this methodology were perceived as guiding and clarifying. Also, some other characteristics such the fact that students could choose their own challenges or the students' involvement in their own evaluation could favour that teachers using CBL were perceived as participative.

1.4. The present study

Considering the above, there is previous evidence of the implementation of certain methodologies that can foster students' motivation in the PE context. Furthermore, it seems that several attempts have been made to incorporate CBL in Higher Education. However, there is no evidence of the impact of this approach on students' motivation within physical activity-related educational contexts. On the other hand, the recent circumplex approach claims that teachers can engage in eight different teaching styles which can motivate or demotivate students, but no studies have addressed student teachers views on their professors' styles under this recently developed perspective. Students' views on this respect might be specially relevant given tha, according to SDT, it is the functional significance of the social environment as perceived by the individual that is the most important variable when predicting the effects of the social context on an individual's self-determination (Deci & Ryan, 1987). Studies which have previously compared teachers' and students' views, as well as their predictive power on students' outcomes, have found that teachers' perceptions of their own behaviours do not predict students' self-determination or engagement as strongly as students' own perceptions of these teacher behaviours (Taylor & Ntoumanis, 2007; Van den Berghe et al., 2015).

Gaining some understanding on how students perceive teachers when they implement a CBL methodology and how students' motivational patterns are affected by the use of this approach is highly relevant to evaluate the extent to which this methodology can be a valuable tool in Higher Education. The present study aims to analyse how CBL could affect student teachers' basic psychological needs satisfaction and frustration in comparison with a traditional teaching (TT) methodology. Teaching styles perceived by student teachers in both conditions were also compared. This study thus adds to the existing literature by answering the following questions: (a) Are there differences in student teachers' basic psychological needs satisfaction and frustration according to the methodology they experience in class (CBL vs. TT) (b) Do student teachers perceive their professors' styles differently according to the methodological approach (CBL vs. TT) they use in class? Considering the CBL features, it is hypothesized that a CBL-based experience can positively impact adaptive student teachers' basic psychological needs satisfaction and prevent student teachers' basic psychological needs

Table 2
Participants distribution according to year, contents they attended and research condition.

Year	N (student teachers)	Contents	N (answers)	Condition
1st	29	Badminton	26	Control
		Karate	29	Experimental
2nd	19	Volleyball	11	Experimental
		Basketball	8	Experimental
		Gymnastics	9	Experimental
		Athletics	10	Control
3rd	18	Swimming	12	Control
		Athletics II	6	Control
4th	17	Soccer	6	Control
		Rugby	11	Control
Total	83		128	

Note. Participants in years 1st and 2nd enrolled in two different sports over the same period and thus completed two different questionnaires. Students in 1st year enrolled in both badminton and karate, while students in 2nd year enrolled either in volleyball and gymnastic or in basketball and athletics. Participants in years 3rd and 4th only enrolled in one of the sports displayed in the table. For each sport students were enrolled in 14 weekly sessions of 100 min.

frustration. Furthermore, according to previous works in which more participative approached had been compared with TT (e.g., Franco et al., 2021; Manninen & Campbell, 2021) it is hypothesized that professors using a CBL methodology will be perceived as more autonomy- and structure-supportive, and less controlling, and chaotic, than professors using a TT methodology.

2. Materials and methods

2.1. Participants

From an initial pool of 86 potential participants who were invited and consented to take part in the study, a total of 83 student teachers studying for a Physical Activity and Sport Sciences degree from one Spanish university located in Madrid participated in the study (the other three were discarded since they did not meet the inclusion criteria of having attended at least 75% of the lessons in the course). Participants' age ranged from 17 to 27 years (M = 20.07, SD = 1.82). Of the total sample, 29 students belonged to the first year (34.9%), 19 students were in their second year (22.9%), 18 students belonged to the third year (21.7%), and 17 students were in their fourth year (20.5%). Furthermore, the sample was comprised of nine professors (six men and three women), aged between 26 and 50 (M = 33.56, SD = 7.14). All of them were graduate in Physical Activity and Sport Sciences as well as national coaches in the sport they were teaching. Furthermore, 5 of them held a PhD in Sport Sciences. Four out of the nine participant professors were assigned to the experimental condition, and five of them were part of the control group. The allocation of the teachers in each condition was made based on the teachers' expertise. The four teachers assigned to the experimental group had engaged in previous training about CBL and had participated in some educational innovation projects around this methodology. All participants had at least two years of teaching experience in the methodology they implemented in the present study. It is worth mentioning that, depending on the year they belonged to, student teachers participated in the control and experimental group (years 1 and 2) or in the control group only (years 3 and 4). Responses were collected for each of the sports contents taught in the Physical Activity and Sport Sciences degree. This means that participants reported their perceptions of their learning experience more than once. Thus, the study sample comprises a total of 128 answers. Table 2 summarizes the collected data according to year, sport, and research condition.

2.2. Instruments

2.2.1. Basic psychological needs satisfaction and frustration

Students' perception of basic psychological needs satisfaction and frustration was assessed using a Spanish version adapted to the PE context (Zamarripa et al., 2020) of the scale designed by Chen et al. (2015). The stem used in the questionnaire was "In my specific sport (e.g., basketball) classes ...", and it was followed by 24 items grouped in six factors. These six factors, composed of four items, correspond to autonomy satisfaction (e.g., "I feel a sense of choice and freedom in the things I undertake"); competence satisfaction (e. g., "I feel capable in what I do"); relatedness satisfaction (e.g., "I feel close and connected with other people who are important to me"); autonomy frustration (e.g., "most of the things I do feel like 'I have to'"); competence frustration (e.g., "I have serious doubts that I can do the activities well"); and relatedness frustration (e.g., "I feel excluded from the group I want to belong to"). Responses were reported on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). The adapted tool used in the present study also yielded a satisfactory goodness-of-fit ($\chi^2(1081) = 459.69$; $p < .001$; $\chi^2/df = 1.92$; CFI = 0.91; IFI = 0.91; RMSEA = 0.06; SRMR = 0.05), and the different items loaded in the expected dimensions. Cronbach's alphas ranged from 0.81 to 0.91.

2.2.2. Teaching styles

A version of the Situations-in-School (SIS) questionnaire designed by Aelterman et al. (2019) was used, adapted for students in the Spanish context (see appendix in supplementary material). The scale consists of 12 vignettes of common situations in class. Each situation presents four different reactions, corresponding to one of the four broader teaching styles (autonomy support, structure, control, and chaos) and to one of the eight types of teaching strategy: participative (e.g., "Invites us to suggest a set of guidelines that will help us to feel comfortable in class"); attuning (e.g., "Asks us what we are interested to know about the learning topic"); guiding (e. g., "Offers help and guidance"); clarifying (e.g., "Makes an announcement about his/her expectations and standards for being a cooperative classmate"); demanding (e.g., "Insists that we finish all his/her required work-no exceptions, no excuses"); domineering (e.g., "Insists that we must act in a more mature way"); abandoning (e.g., "Just ignores the whining and complaining. We need to learn to get over the obstacles ourselves"); and awaiting (e.g., "Doesn't worry too much about the rules and regulations"). Reactions to each situation were provided on a seven-point Likert scale ranging from 1 (does not describe me at all) to 7 (describes me extremely well). The fit indices for the eight-dimension confirmatory factor analysis performed with the sample participating in the present study were adequate ($\chi^2(1081) = 5261$; $p < .001$; $\chi^2/df = 4.87$; CFI = 0.91; IFI = 0.90; RMSEA = 0.06; SRMR = 0.05), and the different items loaded in the expected dimensions. Cronbach's alphas ranged from 0.74 to 0.92.

2.2.2.1. Previous experience and knowledge about methodological approach.
At baseline, students answered two questions regarding their previous experience and knowledge about both methodological approaches (TT and CBL) implemented in the intervention. The questions were "To what extent have you been involved in PE experiences using __?" and "How much do you know about __?" All students had attended the course *Fundamentals of Sport Initiation* in which these two approaches were explained. Responses were reported on a 5-point scale ranging from 1 (nothing at all) to 5 (a lot).

Table 3
Descriptive statistics and correlations of study variables.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Autonomy Satisfaction	1	647**	.397**	−.250**	−.189*	−.012	.430**	.380**	.611**	.475**	.508**	.442**	.117	.139	.091	.035	−.002	.066
2. Competence Satisfaction		1	.612**	−.257**	−.446**	−.211*	.374**	.325**	.522**	.428**	.435**	.437**	−.048	−.022	−.067	−.184*	−.216*	−.136
3. Relatedness Satisfaction			1	−.381**	−.392**	−.492**	.224*	.178*	.392**	.403**	.389**	.424**	−.191*	−.129	−.231**	−.357**	−.372**	−.308**
4. Autonomy Frustration				1	.802**	.797**	.033	−.020	−.147	−.202*	−.212*	−.171	.465**	.392**	.498**	.583**	.604**	.508**
5. Competence Frustration					1	.778**	.079	.015	−.123	−.193*	−.199*	−.172	.387**	.334**	.408**	.548**	.562**	.481**
6. Relatedness Frustration						1	.085	.062	−.043	−.149	−.168	−.132	.470**	.395**	.504**	.629**	.660**	.540**
7. Autonomy Support							1	.538**	.697**	.538**	.534**	.566**	.190*	.186*	.182*	.065	.051	.071
8. Participative								1	.563**	.527**	.513**	.546**	.191*	.183*	.185*	.049	.032	.060
9. Attuning									1	.803**	.820**	.818**	.137	.147	.119	−.059	−.060	−.052
10. Structure										1	.882**	.884**	.150	.199*	.098	−.090	−.093	−.079
11. Guiding											1	.766**	.061	.097	.026	−.151	−.153	−.134
12. Clarifying												1	.197*	.255**	.133	−.082	−.061	−.093
13. Control													1	.961**	.970**	.775**	.826**	.656**
14. Demanding														1	−864**	.709**	.752**	.603**
15. Domineering															1	.783**	.838**	.660**
16. Chaos																1	.945**	.956**
17. Abandoning																	1	.807**
18. Awaiting																		1
M (SD)	3.57 (1.12)	4.00 (1.14)	4.15 (1.11)	2.12 (1.29)	2.01 (1.25)	1.68 (1.07)	4.46 (1.27)	4.36 (1.35)	4.88 (1.26)	5.16 (1.22)	5.24 (1.30)	5.09 (1.24)	3.47 (1.31)	3.69 (1.28)	3.25 (1.43)	2.97 (1.43)	3.11 (1.43)	2.82 (1.57)

2.2.3. Previous experience and knowledge about content

At baseline, students answered two questions regarding their previous experience and knowledge about the content they would be involved in. The questions were "To what extent have you been involved in PE experiences in__?" and "How much do you know about __?". Furthermore, they answered one question regarding their taste for the contents they were going to be involved in (badminton, karate, volleyball, basketball, gymnastics, athletics, swimming, soccer or rugby). Responses were reported on a 5-point scale ranging from 1 (nothing at all) to 5 (a lot).

2.2.4. Design and procedure

The study design was a quasi-experimental post-test aiming to compare the CBL experience (experimental group) and the TT experience (control group). The main features of the two methodological approaches used in each condition are displayed in Table 2 as supplementary material.

The intervention was implemented over 14 weekly sessions of 100 min (per sport content), lasting for three months in the academic year 20–21. All the lessons were taught in the University Sport Facilities. More specifically, the physical learning spaces were an indoor sport court (for badminton, volleyball, karate and gymnastics), a swimming-pool (for swimming), a running track (for athletics), a tatami (for karate), a soccer field (for football), and a rugby field (for rugby). Learners' attendance was assessed by the participant professors, and, on average, it was >85% in both groups. Students who had attended less than 75% of the lessons were excluded of the study. Questionnaires were administered by a member of the research group during the last session of each content. This person explained the aim of the project and emphasized that the anonymity of the participants would be maintained, as well as encouraging the participants to provide their most honest answers to the questions. Student teachers completed the questionnaire in the classroom without the presence of the professor and in a climate that enabled them to concentrate without any type of distraction; it lasted for 25 min.

The study obtained approval from the Ethics Committee of one Spanish university. All participants were treated in agreement with the ethical guidelines of the American Psychological Association (2002) with respect to consent, confidentiality, and anonymity of their answers. By means of a computerized application, four sessions of each condition were randomly selected and analysed by two members of the research team. In order to ensure that the methodology was implemented as planned, a checklist was created. It consisted of nine indicators for each condition that coincided with the features displayed in Table 2 of Supplementary Material. The two PE expert researchers checked it separately. The intra-class correlation coefficients were high both for the traditional (ICC >0.92) and the challenge-based teaching (ICC >0.85).

This study has been reported following the Guideline for reporting evidence-based practice educational interventions and teaching (GREET; Phillips et al., 2016). A detailed checklist indicating the compliance of the present study with these recommendations is provided as Supplementary Material (Table 3).

2.3. Data analysis

Prior to the study, a sample size calculation (Rosner, 2011) was made considering a type I error of 0.05, and power of 80% for comparing continuous outcomes between two different-size and independent study groups. It resulted in the need for 69 subjects. Given that our study subjects were participants' responses (n = 128) the sample-size requirements were met. For the study, firstly, descriptive statistics (mean and standard deviation) and correlations among all the study variables were calculated. A Kolmogorov-Smirnov test was then performed to verify the normality of the data and show that it was non-normally distributed (p < .05), except for the variable of age (p >.05). Thus, non-parametric tests were used to analyse differences between groups in all variables except for age. Firstly, an independent samples *t*-test was performed to analyse differences between the groups in terms of age. Furthermore, some Mann-Whitney tests were performed to analyse possible differences between the groups in terms of previous experience, and knowledge about both the methodology and the content; and taste for the content. After the intervention, Mann-Whitney tests were also used to analyse differences in terms of basic psychological needs satisfaction and frustration as well as perceptions of professors' teaching styles. The effect sizes of the comparisons were estimated using Cohen's d. The SPSS 24.0 software program was used to process the data.

3. Results

3.1. Descriptive statistics

The descriptive statistics and bivariate correlations are reported in Table 3. In general, the scores for basic psychological needs satisfaction were higher than needs frustration. The scores for perception of autonomy support and structure were also high. Specifically, guiding and clarifying teaching styles, corresponding with the dimension of structure, showed the highest values between all teaching styles. On the other hand, chaos teaching style (abandoning and awaiting) presented the lowest scores. Overall, Pearson correlations showed significant and strong relationships between all the study variables. Satisfaction of basic psychological needs positively correlated with autonomy support teaching styles (participative and attuning) and structure teaching styles (guiding and clarifying), but negatively with control (demanding and domineering) and chaos style (abandoning and awaiting). Negative and significant correlations were also observed between basic psychological needs frustration and control and chaos style. In addition, positive correlations were observed between autonomy support style and structure and control styles.

3.2. Differences between groups in the intervention

Aiming to ensure that students in the CBL condition were not significantly different from those in the TT condition (in some potential confounders), we performed independent-sample difference tests before the intervention. No differences were found between groups in terms of previous experience in TT (M_{TT} = 4.71 vs. M_{CBL} = 4.42, t = 0.13, p = .13) or CBL methodology (M_{TT} = 3.56 vs. M_{CBL} = 3.97, t = 1.85, p = −0.06), previous knowledge about TT (M_{TT} = 4.71 vs. M_{CBL} = 4.72, t = 0.21, p = -0.83) or CBL (M_{TT} = 3.71 vs. M_{CBL} = 3.78, t = 0.01, p = -0.99), previous experience (M_{TT} = 3.32 vs. M_{CBL} = 3.58, t = 1.22, p = -0.22), knowledge (M_{TT} = 3.85 vs. M_{CBL} = 4.08, t = −1.04, p = -0.30) or taste (M_{TT} = 4.22 vs. M_{CBL} = 4.31, t = −0.22, o = -0.83) about content.

Table 4 shows the differences between students' scores in the experimental and the control group after the intervention. For basic psychological needs, the results showed that the experimental group had a higher level of competence satisfaction and a lower level of competence frustration. On the other hand, relatedness frustration was higher in the control group than in the experimental group. In terms of teaching styles, the experimental group differed from the control group in the perception of autonomy supportive teaching. More specifically, students in the experimental group reported a higher perception of participative strategies. Significant differences were also observed in perceptions of a structure-supportive teaching style. In this case, students perceived greater use of guiding and clarifying strategies in the experimental group than in the control group. No differences were found between groups in terms of controlling and chaotic teaching styles.

4. Discussion

The first aim of this study was to analyse how a CBL-based experience may affect student teachers' basic psychological needs satisfaction and frustration in comparison with the implementation of TT within a physical activity-related educational context. Secondly, it aimed to compare teaching styles perceived by students according to the methodology under which they were being taught (CBL and TT).

As hypothesized, implementation of a CBL-based experience led to more positive outcomes that implementation of a TT-based methodology. More specifically, differences were found in competence satisfaction and frustration, and in relatedness frustration. As for the teaching styles, student teachers in the CBL-based experience perceived their professors as using more autonomy supportive strategies and structuring strategies than student teachers in the TT group. Overall, the present study findings align with existing literature in terms of how a CBL might positively impact students' adaptive outcomes (Gallagher & Savage, 2020). While other studies have found CBL to improve technical skills or thinking ability e.g., Kohn Radberg et al., 2018), this study provides some new empirical evidence on an understudied population: university students undertaking a Physical Activity and Sport Sciences Degree. In this case, the study findings suggest that, when experiencing a CBL approach, university students might be more likely to favour desirable motivational patterns. The close association existing between some of the constructs under study (i.e., competence satisfaction) and some constructs previously addressed in the university context such as technical skills or improving problem solving skills, lead us to think that benefits identified in the present study might be generalizable to other university subjects.

4.1. Structured teachers, competent students

According to the results, competence seems to be the need most influenced by CBL. Previous studies have suggested the existence of

Table 4
Differences in study variables between CBL and TT conditions after the intervention.

	TT(N = 71) M (SD)	CBL (N = 57) M (SD)	Z	p	Cohen's d
AUTONOMY SATISFACTION	3.76 (.84)	3.72 (.78)	−.12	.91	.03
COMPETENCE SATISFACTION	3.80 (1.02)	4.21 (.57)	−2.17	.03	.43
RELATDNESS SATISFACTION	4.25 (.73)	4.48 (.51)	−.84	.40	.34
AUTONOMY FRUSTATION	2.40 (1.25)	2.16 (1.08)	−.36	.72	.11
COMPETENCE FRUSTATION	2.46 (1.15)	1.87 (1.06)	−2.52	.01	.27
RELATDNESS FRUSTATION	1.99 (1.58)	1.58 (.83)	−2.09	.04	.02
AUTONOMY SUPPORT	4.34 (1.25)	4.78 (.96)	−2.14	.03	.39
Participative	4.20 (1.29)	4.72 (1.12)	−2.34	.01	.42
Attuning	4.82 (1.18)	5.09 (.98)	−1.49	.13	.27
STRUCTURE	5.04 (1.09)	5.46 (.92)	−2.52	.01	.46
Guiding	5.12 (1.16)	5.56 (1.03)	−2.51	.01	.46
Clarifying	4.96 (1.15)	5.40 (.89)	−2.49	.01	.46
CONTROL	3.38 (1.23)	3.68 (1.24)	−1.63	.10	.29
Demanding	3.64 (1.17)	3.84 (1.22)	−1.32	.18	.24
Domineering	3.11 (1.38)	3.50 (1.34)	−1.91	.05	.34
CHAOS	3.02 (1.40)	3.01 (1.33)	−.23	.81	.04
Abandoning	3.14 (1.43)	3.16 (1.30)	−.52	.59	.09
Awaiting	2.90 (1.54)	2.79 (1.48)	−.09	.92	.02

a relationship between CBL and actual learning (Ogbuanya et al., 2021; Ojasalo & Kaartti, 2021). Ojasalo and Kaartti (2021) pointed out that CBL might enhance all areas of significant learning taxonomy, while Ogbuanya et al. (2021) suggested that another factor which could enhance competence satisfaction among participants is that in the CBL condition student teachers were allowed to participate actively in the classroom. Therefore, while studies implementing CBL in university contexts are highly heterogeneous (Gallagher & Savage, 2020), the literature suggests that there must be certain core characteristics of CBL, such as the provision of choice and the promotion of active participation, which could lead to greater learning and competence satisfaction in the university context.

Focusing on experiences developed in the physical activity-related educational context, plenty of studies have provided evidence as to how certain strategies, representative of different methodological approaches (such as the creation of a needs supportive environment, the implementation of strategies fostering a task-oriented motivational climate, the use of inclusion styles or SEM) can enhance the perception of competence. These methodologies have some features closely related to the characteristics of the methodology used in this intervention, which could explain the positive effect on competence satisfaction. Firstly, the provision of optimal challenge (Almolda-Tomás et al., 2014; Franco & Coterón, 2017; Kirby et al., 2015) seems to be a valid tool to promote feelings of competence. In the present intervention, this outcome could have been achieved through the presentation of different levels of challenge. Secondly, findings suggest that the clear establishment of standards and evaluation criteria might help student teachers to be aware of their achievements and thus improve their competence satisfaction (Almolda-Tomás et al., 2014; Kirby et al., 2015). The CBL-based experience in the present study provided students with clear expectations through the provision of images and videos. Lastly, it is worth mentioning the role of cooperative activities (Almolda-Tomás et al., 2014; Franco & Coterón, 2017; Kirby et al., 2015). The fact that student teachers could collaborate in pursuit of the established objectives might have been a key element in the fostering of competence feelings. Considering the above, the findings of the present study contribute to the existing literature by providing some thoughts on the question of why students feel competent in physical activity-related educational contexts.

Participants in the experimental group also reported higher scores for perception of a structuring teaching style than those in the control group. This finding could have been predictable according to the proximity between the behaviours from the structuring style and the CBL characteristics. According to Aelterman et al. (2019), when displaying this style, professors can rely on clarifying and guiding teaching strategies. Interestingly, differences between the control and experimental groups for both guiding and clarifying teaching strategies were significant. This finding is not surprising considering the characteristics of the proposal developed in this intervention. As for the clarity of expectations (guiding strategies), the fact that the CBL-based experience in this proposal was organized in three clearly established phases (familiarization, progression and achievement), which were presented at the beginning, helped student teachers to be aware of what their professors expected from them. The initial establishment of different level challenges might have also contributed to make clear these expectations. On the other hand, guidance for student teachers to achieve their expected outcomes (clarifying strategies) was possible due to two different aspects: firstly, the fact that challenges to be tackled were available to students from the beginning might have acted as a guidance resource (students could know what was next); and secondly, since graphical resources (videos or images) were used in the group who experienced CBL to present the activities, professors were freed of this duty and thus could more thoughtfully guide student teachers during their practice. It has been suggested that the provision of expectations and monitoring may shift to a more demotivating side if presented in a controlling way, and professors sometimes express anxiety about providing too much structure, fearing that it might lead to demotivating control (Aelterman et al., 2019; Escriva-Boulley et al., 2021). In fact, previous studies have found a significant correlation between the sub-areas of clarifying and demanding (Aelterman et al., 2019; Vermote et al., 2020). However, in the present study, no differences were found between groups in the control teaching style. This finding prompts us to think that CBL might be a suitable educational framework to foster a structure-supportive teaching style, reducing the risks of acting in a controlling way.

The fact that student teachers in the CBL group reported both higher competence satisfaction and perception of a structure-supportive teaching style is in line with the theoretical postulates and existing empirical evidence suggesting that when professors adopt a structuring style, they are more likely to facilitate student teachers' competence satisfaction (Aelterman et al., 2019; Cheon et al., 2020). These findings also provide evidence of this relationship between a structuring teaching style and competence satisfaction in an unexplored setting: the university context.

4.2. Relatedness frustration in physical activity-related educational contexts

According to our results, the levels of relatedness frustration had significantly higher values in the control group. This finding is in line with the results of the recent study by Bessa et al. (2021), in which TT and SEM were compared in terms of how they influence student teachers' basic psychological needs. In this work, student teachers reported higher levels of relatedness frustration in the TT condition. According to existing literature, TT does not seem to favour team affiliation or group decision-making, which might prevent the relationship between students from improving (Bessa et al., 2021). It has also been suggested that, when using TT, professors do not allow students to internalize and attribute importance to certain social values in physical activity-related educational contexts (Burgueño et al., 2017). Moreover, TT limits the possibility for students to adopt particular roles and responsibilities (Spittle et al., 2009). These limitations of traditional approaches favour the creation of environments likely to thwart relatedness frustration among student teachers, who could adopt passive and reproductive behaviours. Future research could further explore the specific features of TT leading to relatedness frustration. It would allow us better to identify the less desirable aspects of this approach and thus adapt methodological proposals so that its implementation does not jeopardize student teachers' relatedness need.

4.3. Autonomy supportive teaching style and challenge-based learning

Regarding teaching styles, the findings of the present study showed higher levels of perception of autonomy support among those student teachers that were taught using the CBL methodology. Looking into the results, this difference was due to a stronger perception of participative strategies in the experimental group. One of the participative strategies identified in the literature is the provision of choice (Patall et al., 2013). Escriva-Boulley et al. (2021) suggested that professors can provide students with the opportunity to choose either the activity or the skill level. Skill level choice was a main characteristic of the CBL in this intervention, since students could choose the challenges they wanted to perform according to their own perceived competence (see supplementary material, Table 2). According to Escriva-Boulley et al. (2021), the skill level choice (or option choice) is representative of both participative and attuning strategies.

Interestingly, no differences in attuning strategies were found between the control and the experimental groups in the present study. This finding is somewhat surprising, considering that Delrue et al. (2019) suggested that attuning and guiding strategies are highly likely to co-occur. In Delrue et al.'s study (2019), teaching styles were analysed without any relation to a specific methodology (i.e., teachers did not have specific indications as to methodological strategies). However, in the present work, professors were trained and urged to follow a specific methodology (traditional or CBL). Thus, based on CBL features, professors might have been more likely to use guiding strategies by presenting different level challenges at the beginning of the lesson, explaining challenges with graphical resources, or giving feedback during the practice. However, the present study results suggest that attuning strategies might rely on dispositional factors regardless of the methodological approach. In this line, it was also found that domineering style was significantly different between groups after the intervention, even though control dimension did not differ. It would be plausible that some CBL features (giving specific instructions and guiding the students to achieve the challenges), might be perceived by the students as a more controlling teaching style. These findings invite us to think that teaching styles might not be permanent and there are thus certain teaching strategies which could be trainable. This opens an interesting avenue to develop teacher training programmes to promote those teaching strategies that nurture positive motivational outcomes between students.

4.4. Practical implications

The present study has allowed us to better understand the influence that the use of a specific methodology, CBL, has on student teachers' motivation and perception of teaching styles. The main conclusion drawn is that the use of challenge-based learning can support basic psychological needs. This means that when professors embrace the key pedagogic of this methodology, they are more likely to promote more motivating contexts.

Furthermore, certain characteristics, such as suggesting individual progression, offering choice, communicating clear and transparent expectations, or identifying students' interests can be implemented regardless of the specific methodology that teachers use in the PE class. Thus, providing teachers with training and feedback can allow them to monitor and customize their use of strategies to foster a need-supportive climate and avoid controlling situations.

The Situations-in-School Spanish version for student teachers could also be helpful for future professors' training. Providing student teachers with the opportunity to observe and assess their own practices based on the teaching styles established by the circumplex approach can strengthen their analysis competence and their thoughtfulness in higher education contexts. This could help student teachers to identify and understand the mechanisms by which certain models can be more motivating than others.

4.5. Strengths, limitations, and directions for future research

This study contributes to one of the gaps highlighted by Vasconcellos et al. (2019), that there are relatively few quasi-experimental studies based on self-determination theory in physical activity-related educational contexts. It also provides a fine-grained view on the association between a methodological approach and teaching styles from a circumplex perspective (Aelterman et al., 2019).

Nevertheless, this study is not without limitations. Firstly, these findings must be interpreted with caution because all the data were based on students' self-reportedquestionnaires. Future research could overcome these problems by using a mixed methods approach to triangulate results (i.e., professors' and student teachers' perceptions of teaching styles, and observation of teaching styles). The second limitation is related to the sample size. The small group sizes were due to the difficulties inherent in conducting a supervised intervention study in a physical activity-related educational context. It would be interesting to use a larger sample size in future studies, which would allow us to apply predictive statistical techniques to determine whether the differences found in some variables between the control and experimental groups may be due to changes produced by other variables. It is also worth mentioning that the lack of a pre intervention measure as a limitation. This information was not collected since we could not guarantee that participants had had similar previous experiences in terms of methodological approaches. However, future studies should provide some longitudinal evidence on the effect of experiencing a CBL-based methodology. The fact that participants belonged to different years might have had an impact on the results. The potential influence of the university year on perceptions about teachers' behaviours could be explored in future works. Lastly, future studies should also perform a manipulation check to determine the effectiveness of a manipulation in an experimental design.

5. Conclusions

This study represents the first attempt to date to examine the influence of a CBL intervention in a physical activity-related

educational context on student teachers' motivation and perceptions of professors' teaching styles. The findings of the study highlight the CBL model's potential to foster students' competence satisfaction and, suggest that professors are more likely to be perceived as guiding and clarifying when implementing this methodology. Similarly, it seems that the CBL approach can promote a participative teaching style. Overall, the present work suggests that embracing the key features of CBL can be a promising avenue for improving physical activity-related educational settings from a motivational perspective.

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Declaration of competing interest

The authors report that there are no competing interests to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jhlste.2023.100432.

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