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Abstract

Purpose: Providing students with enjoyable experiences in Physical Education (PE) is considered a key variable in research on increasing Physical Activity (PA) levels. Designing game formats in PE is relevant to achieving this aim. Coupling principles of Motor Praxeology (MP) and the Constraints Led Approach (CLA) to design three games, the aim of this study was to examine how participants' sex, age and skill levels (organismic constraints) interacted with varied manipulations of task and environmental constraints in the organisational design of badminton games to increase their enjoyment and PA.

Method: Participants were students (n=55, Mage = 14.0, SD = 2.41, 41.8% girls, aged 11–19) enrolled in a PE unit with three distinct badminton organisational designs for games: Individual Tournament (IT), Team Score (TS) and Personal Challenge (PC). IT challenges students in a group of a homogeneous skill level with a one-on-one competition. TS consists of a series of one-on-one games amongst a group of students with a heterogeneous skill level. PC is a competition between students in a heterogenous-level group, adopting a handicap score system. Enjoyment and level of PA was measured using a pleasure scale and accelerometers.

Results: Results indicated little effect of organisational design on pupils' enjoyment but showed a difference in their PA: younger and skilled boys moved less in the PC design compared to the TS organisational design.

Discussion/Conclusion: Our results suggest that potential interactions between the format of the organisational design and individual differences in students could be relevant for increasing PA in PE programmes. In exploring effects of interactions of organisational designs for games, goal tasks and students' characteristics, a combination of MP and CLA frameworks helps to address some of the prevailing beliefs about pleasure and the commitment made by students in common physical education play and activity formats. Our study showed that there is no ideal

organisational design for engaging students, but that the most fruitful formats depend on the specific interests of the students.

Practical Implications: These theoretical frameworks invite PE teachers to develop organisational designs by providing interaction between goal-oriented tasks and social variables (e.g., relationships between players) to provoke richer experiences in all students from different skill levels.

Keywords: Enrichment, organisational design, physical education, physical activity, Badminton.

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Introduction

At a time when sedentary lifestyles are a major concern raised in educational and public health policies, formal Physical Education (PE) classes in many school syllabi provide an opportunity to increase Physical Activity (PA) among adolescents (Somerset and Hoare 2018). However, PE teachers may not succeed in achieving this goal if organisational design is not sufficiently rich to engage students, especially those who are not spontaneously attracted to sport (Dudley et al. 2011). To address this issue, school curricula can promote a high-quality PE programme, based on enriched learning experiences stimulating participation in sports, exercise and recreation (Rudd et al. 2020). Enriched learning designs contain a multitude of opportunities for action which requires the integration of cognitive, emotional, social, perceptual and physical dimensions of behaviour (Button et al. 2020, Rudd et al. 2020; Renshaw et al. 2010; Woods et al. 2020). They are dynamic, challenging and enjoyable because they are focused on specific learners' interests and needs (Headrick et al. 2015; Pinder et al. 2011; Renshaw et al. 2016). Amongst the positive benefits of such designs, research has emphasised that enjoyment is one of the best predictors for promoting PA inside the school setting (Lonsdale 2013; Jaakkola et al. 2017). Yet further research is needed to investigate the effectiveness of interventions in PE settings to improve enjoyment and physical engagement (Dudley et al. 2011). Coupling the Constraint Led Approach to skill acquisition (Davids 2008; Renshaw et al. 2010; Rudd et al. 2020) and Motor Praxeology (Parlebas 1999) provide an interesting theoretical approach to this practical challenge, as they capture how to enrich learning experience in sport and PE and appear operational for categorizing sport tasks (Martínez-Santos et al. 2020).

Contribution of the Constraint Led Approach: A Holistic Framework for Measuring Interactive Effects in Learning Design

Literature focusing on psychological (e.g., enjoyment) or physiological (e.g., amount of PA) outcomes in PE settings present methodological and theoretical issues because they have focused on specific variables related either to individuals or to pedagogical environments, but rarely the 'deeply intertwined' relationships between the two (Rudd et al. 2020). The topic of enjoyment in PE settings has largely been explored at the individual level, investigating differences in sex (Azzarito and Solmon 2009; Garrett 2004); skill levels (Barker, Larsson and Nyberg 2019; Fairclough 2003; Light 2003); and age (Trujillo et al. 2004). At an environmental level, results revealed effects of task aim (Chen and Darst 2001; Roure and Pasco 2018) and social interactions (Lentillon-Kaestner and Patelli 2016) on levels of enjoyment. With respect to studies of PA, although Zhou and Wang (2019) conducted a systematic review investigating the effects of eight individual and environmental variables on PA (sex, ethnicity, class gender, PE activities, lesson location, expectancy level, subjective task values and enjoyment), their scrutiny of the data did not involve multivariate analysis considering the contribution of each variable.

To tackle these methodological and theoretical issues, the Constraint Led Approach (CLA) to skill acquisition (Button et al. 2020) defined the *individual-environment relationship* as an appropriate level of analysis to study human behaviours. From a practitioner perspective, adopting a CLA consider learners as complex, adaptive dynamical systems, co-adapting with events, objects and significant others in ever-changing learning and performance environments. Engagement in learning designs is thus considered as an emergent phenomenon resulting from the interactions between three categories of constraints: organismic (related to an individual's characteristics); environmental (related to external physical and social characteristics); and task (related to the specific goals of an activity).

Although a CLA has typically been used to explain skill adaptation in PE and sport, it may also be used to understand enjoyment and PA as 'emergent phenomena' (e.g., Yeh et al. 2016). Indeed, a CLA perspective highlights the role of affective (emotional) constraints on behaviour. In the ecological dynamics' framework, which underpins the CLA approach, emotions may continuously interact with a learner's intentions, cognitions, perception, and actions to constrain the skill adaptation process and the development of expertise (Davids 2008). The ongoing and deeply integrated interactions between affect, cognitions, perceptions, and actions, provide a principled basis to promote affective learning designs in sport and PE (Headrick et al. 2015).

Contribution of Motor Praxeology: A Relevant Framework for Categorizing the Organisational Tasks in PE

From the perspective of enriching learning experiences in PE, by avoiding the weaknesses of the traditional Skill Drill Technical Model (Rink et al. 1996), some game-based approaches, such as TGfU (Bunker and Thorpe 1982), Game Sense (den Duyn 1997), Sport Education (Siedentop 2002), have been proposed as a suitable pedagogical refinement. The CLA and some game-based pedagogical approaches, particularly TGfU, have been associated in pedagogical discussions (Nathan 2016; Renshaw et al. 2016) because they require the design of learning environments that successfully sample and represent conditions of performance contexts in practice simulations. Nevertheless, there are major differences between them, especially the emphasis in game-based approaches to focus on perceptual-cognitive development and skills of students through decision-making during conditioned practices and games. In contrast, the CLA is predicated on theoretical principles of ecological dynamics which advocate the mutuality of individual-environment relationships as paramount in understanding the link formed between perception and action during practice and learning. This link is enhanced with learning, skill and expertise, leading individuals to realise available affordances (Gibson, 1979) for behavior in the environment (for a more detailed explanation see Renshaw et al. 2016). To

achieve a better alignment with CLA principles, game-based pedagogical approaches in sports could take their lead from a rationale based in Motor Praxeology (Parlebas 1996, 1999) because: "*concepts like understanding, game sense and action principles are operatively and semiotically linked to the process of playing*" (Martínez-Santos et al. 2020, 11). Thus, Motor Praxeology (MP) shares CLA's idea that behavior in sport is predicated on the mutuality of the individual-environment relationship. Although the Gibsonian concept of affordances for behavior is not mentioned in the conceptualization of Parlebas, he does recognize that: "Perception and action become one in the unity of the motor conduct" (Parlebas, 1981: 97-98). Grounded on the key idea that the inner structures of games can constrain participants and guide their movement re-organisation, Parlebas (1996, 1999), modelled motor communication networks for categorising sports and games (see Figure 1).

[Figure 1 near here]

This categorisation is based on relationships between participants, especially if networks are *n-exclusive* (any two participants cannot be at the same time partners and opponents as in some traditional games such as 'seated-ball' game), *stable* (the initial relationship between any two players is maintained until the end of the competition), *complete* (there is always a positive or negative relationship between any two players, never neutral), and *balanced* (intra-team relationships are always positive and inter-team relationships always negative).

The major potential contribution of MP is the design of learning situations in PE that guides the choice of game formats, based on communication typologies between players (e.g., individual vs team competitions, matches with handicaps). In this framework, enriching learning experiences consists of not only promoting the decision-making process in learners through undertaking modified/conditioned games and practices (e.g., adapting task constraints to reduce or increase the dimensions of a playing area), but also by manipulating the meaning and value of games perceived by participants which shape their affective behaviours. Thus, the motor-

communication network of MP is well aligned with the CLA concept of affective learning design (Headrick et al. 2015). MP postulates that "what affects me sets me in motion", and its socio-motor classification (Parlebas 1996; See Figure 1) could support the key tenets of CLA, in challenging teachers to ask "how to effectively manipulate constraints, and particularly emotions in learning design, to enhance the development of engagement in sport" (Headrick et al. 2015, 84).

To summarize so far, in this study, from the perspective of enriching learning experiences in the contexts of PE, the MP and CLA were used in an integrated and complementary manner to explore the effectiveness of the organisational designs in PE programmes. While the MP framework provides a categorization system for designing play and activity organisation used in learning tasks, the CLA framework provides a strong theoretical explanation of how task and environmental factors may interact with personal factors to shape and guide enjoyment and PA experiences of participants.

Enriching Learning Design in Badminton PE Lessons: A case in point

In French PE programmes, Badminton has become one of the main sports offered to and enjoyed by students (Deslauriers 2007). French PE teachers currently use different badminton learning designs such as Individual Tournament (IT), Team Score (TS) and Personal Challenge (PC) in order to improve the students' interest (Dieu and Llena 2019). Following CLA, engagement in these learning designs is considered as a potentially transient behaviour that emerges from interactions between three types of constraints: individual characteristics (e.g., age, skill level or body composition); the perceived learning design goal(s) (e.g., win the match against an opponent, learn tactical skills to play in a pair); and the physical (e.g., playing with feather or plastic shuttlecocks, different court dimensions) or social environment (playing individually or in pairs, with classic or different scoring systems, with a positive or negative

balance of power). We note that the aforementioned environmental variables are also highlighted in Parlebas's work (see Figure 1).

Following the MP approach an Individual Tournament is a *stable,* 2-*exclusive* and *symmetric duel*, in which an important goal-oriented task is to score more points than an opponent. Team Score is a *stable, n-exclusive and symmetric duel*, in which the main aim is not only for participants to score more points than their opponents, but above all to score as many points as possible (or lose as few as possible) to ensure that their partners can start their matches with a scoring advantage. Personal Challenge is a *stable, 2- exclusive and asymmetric duel*, in which the main goal of the task is to choose the right opponent to challenge and make tactical decisions within a match to exploit their handicap score to win. Although these three game formats are commonly used in professional practice, their proposed effects on student engagement and student perceived enjoyment in PE programmes have never been assessed in empirical research studies.

Purpose of the study

The aim of this study was to assess how participant characteristics (exemplified in demographics, such as sex, age and skill levels), interacted with the different formats of games in competitive badminton (e.g., *n* players, symmetric opposition) to influence their enjoyment and PA.

Materials and methods

Participants

Ninety-three students and five certified PE teachers (three males, two females) from five PE programmes, in three middle schools and two high schools located in France, volunteered to participate in the study. Students were informed of the option to participate in this study by an

information letter and a consent form, which they were invited to complete. The protocol was as follows: (a) participate in a badminton unit (three sequences made up of three game formats); (b) play a minimum of three matches in each format; (c) wear an actimetric belt equipped with a GT3X ActiGraph; and (d) fill out an approved French-language scale of ten, self-report items just after playing a game sequence. Among the 93 participating students, 55 students (23 females and 32 males aged 11–19 years: age = 14.04 ± 2.41 years) could be included in the study because they followed the entire required protocol (a, b, c, d). We have determined sex according to the student's response in the scale in which they were asked to characterise their sex, and we decided to use the term according to Peters and Norton guidelines (2018). To "classify" participants, we used a skill level typology, called conative classification, specifically applied to badminton (Dieu et al. 2020). Participants were observed and classified into a conative stage: (1) structural, (2) functional, (3) technical, (4) contextual and (5) expertise, according to the publication criteria in the study of Dieu et al. (2020) (Table 1).

[Table 1 near here]

These indicators were related to the participants' expertise levels, derived from the three components described in the conative framework: the physical component based on the length of rallies (Dieu et al. 2020), the tactical component with the shuttlecock trajectories and the observed ratio between forced and non-forced errors (Laffaye, Phomsoupha and Dor 2015) and the technical component with the observation of arm and trunk actions in overhead forehand strokes (Wang, Liu and Moffit 2009). Pre-intervention data collected during the first lesson revealed that the participants were categorised in the three first stages of the conative model: 24 novices (first conative stage), 21 at an intermediate level (second stage) and 10 more skilled (third conative stage). In accordance with French law and the European regulation on data protection, an authorisation was registered by the ethical board of the Littoral Opal Coast

University. Students' parents were informed about the scope of the study and consent was obtained from all participants.

Design of badminton unit and description of organisational design

[Figure 2 near here]

Three organisational designs for games are proposed in Figure 2. The first of these, referred to throughout the manuscript as the "Individual Tournament" (IT) (known as a "ladder" in English) consisted of multiple single matches between students organised on several courts ranked on performance from one (i.e., the highest) to seven (i.e., the lowest). After each match, lasting for four minutes, winning students moved to a higher-ranked court, whereas students who lost the match moved to a lower-ranked court. In this task, the goal was to win matches against different opponents in order to reach and maintain position on the highest ranked court. In sum, IT is a *stable*, *2-exclusive* and *symmetric duel*, which challenges students in a group of a homogeneous skill and experience level with a one-on-one competition. In this game, the perceived task goal is to score more points than opponents.

In the second organisational design, referred to as the "Team Score" (TS), students were asked to set up groups composed of one less skilled player, one intermediate player and one highly skilled player. The composition of each team guarantees that each player had the chance to win their match, since each match pitted players of the same skill level against each other. Each student played a single match of four minutes with a cumulative score running for each team, throughout the three matches. The following order for the matches was fixed: low-skilled players, intermediate-skilled players and high-skilled players (low skilled players played against low skilled players and so forth). The cumulative scoring system was used to promote collaboration between the students of different skill levels in the same teams, in order to achieve the outcome of a team victory. In sum, TS is a *stable*, *n-exclusive and symmetric duel*, which

consists of a series of 1 vs 1 games amongst a group of players with a heterogeneous skill level. Adopting a cumulative scoring system, in this game the goal of the task is for the students to score as many points as possible (or lose as few as possible) to ensure that their teammates could start their matches with a scoring advantage (or with the lowest scoring disadvantage possible).

In the third organisational design, referred as "Personal Challenge" (PC), less skilled students could challenge a higher-ranked player in a single game lasting four minutes and started with a positive handicap (which depended on the degree of difference in performance between the opponents). The handicaps were 4 or 7 points according to the skill level (one or two, respectively). In sum, PC is a stable, 2-exclusive and dissymmetric duel, which consists of competition between individuals in learners in a heterogenous-level group. Adopting a handicap score system, in this game, the perceived goal is to choose the right opponent to challenge and make good tactical decisions within matches in order to successfully exploit their handicap score to win.

In these three organisational designs for games, one part of the task constraints was fixed and remained as winning the match. However, changing the social organisational design (environmental constraint) impacted the students' perceived goals within the competitive framework of the game and their activity according to their level (posing the fundamental question: How to win the match?).

Standardisation of interventions

Prior to the study, training sessions were organised for the five teachers involved in this research. First, video clips of students playing badminton were used to train teachers to classify students according to the first three conative stages (4 and 5 were rare in school). Teachers were evaluated after the training session on their capacity to recognise these skill levels (described

in Table 1) with an error margin of 5%. During the study, all participants were video recorded and two analysts (the trained teacher and an expert) classified the players individually, according to the conative stages. If there was any doubt concerning which conative stage best described a student's abilities, that student was removed from the study. Second, to ensure content accuracy, teachers' contributions were evaluated with the same learning design benchmarks: student goals, activity description, material, duration of sequences, student organisation. To avoid any unintended influence of teacher activity on enjoyment experienced by students, teachers were forbidden from providing feedback (positive or corrective) to participating students during the learning design.

Data collection

This study took place during the students' regularly scheduled PE classes, which are held once a week in France, from January to June 2018. The badminton unit was made up of at least six lessons of two hours length each. In the first two, students were observed and classified in expertise level and familiarised with wearing the actimetric belt. Students then participated with a one-week interval between each learning design. The amount of PA undertaken by each participant was collected by accelerometers. Immediately after practising each learning design, students responded to the validated scale. To minimise students' tendencies to give socially desirable responses, all students were assured that their responses would remain anonymous and confidential.

Data measurement

Enjoyment reported — The perceived level of enjoyment was assessed at the end of each activity sequence using an approved French-language scale of ten items rated on a seven-point Likert scale from "strongly disagree" (1) to "strongly agree" (7) (Delignières and Perez 1998).

PA — Each participant wore an accelerometer (Actigraph GT3X) on the lower part of the spine while playing a 4-minute badminton game in the IT, TS and PC learning design. Accelerometers evaluated students' physical activity levels on the basis of the mechanical measurement of movements; the frequency, duration and intensity data of the physical effort were thus recorded. The quantity of PA was calculated in terms of vector magnitude (VM), which was the square root of the sum of the squares of each axis (VM_X, VM_Y and VM_Z) of data.

Statistical analysis

For all quantitative variables (Enjoyment Reported score (ER) and PA) mean and standard deviation were calculated. Qualitative variables (sex, age and conative level) were described in terms of frequency and percentage. Normality and sphericity of the repeated measures data were assessed by the Shapiro-Wilk's and Mauchley's tests. The effect of the learning design on PA and ER was measured using a linear mixed model, with simple effect tests, including PA or ER as a dependent variable to explain effects of the type of learning design, ability levels, age, and sex (fixed effect), the student and the interaction term: student * type of learning design were modelled as random effects. Post-hoc comparisons between the types of learning design were performed by correcting the risk of a type I error using the Bonferroni method. Bilateral tests were performed with a statistical significance level of 5%. Statistical analyses were performed using SAS software (SAS Institute version 9.4). Magnitudes of all the significant differences were examined using effect size (ES) calculations with Cohen's recommendations (1988) to consider the effect small when $\eta^2>.01$, medium when $\eta^2>.06$ and large when $\eta^2>.14$.

Results

All the results are presented in Tables 2, 3 and 4, which show the effects of each organisational design (environmental constraints), as well as the influence of participant sex, age and skill level (organismic constraints), on enjoyment and PA.

Effect of environmental constraints (organisational design) on engagement and enjoyment.

Results showed no significant effect of organisational design on the level of enjoyment, but a significant effect on PA (Table 2). In the TS organisational design, students reported significantly higher PA than in the PC design (107.1 ± 34.2 counts *vs*. 91.2 ± 27.6 counts, for TS and PC organisational designs respectively, $p < .05$, ES = .49).

[Table 2 near here]

Effect of organismic constraints (sex, age and skill level) on engagement and enjoyment

Negative effect of challenge was present in boys, but not girls.

There was no significant effect of sex on the level of enjoyment in any organisational designs, but a significant effect was identified only for high skill levels in PA (Table 3) with male students in the TS and in the IT organisational designs reporting significantly higher PA levels than in the PC organisational design (92.1 ± 24.1 counts/sec in PC vs 107.6 ± 31.7 counts/sec ($p < .05$, ES = –.05) and 109.2 ± 31.9 counts/sec ($p < .05$, ES = .63), for IT and TS respectively). With regard to female students, there was no significant difference observed in PA according to organisational design for games.

Negative effect of challenge was present among young students

Age had no significant effect on the enjoyment reported in any of the organisational designs, but a significant effect was identified for the students of middle-school age (age < 16 yrs) in the TS organisational design with a reported higher PA level than in the PC organisational design (99.5 ± 34.7 counts vs. 84.6 ± 27.2 counts, for TS and PC organisational designs respectively, $p < .05$, ES = .51). In youths of high-school age (age > 16 yrs), no significant difference was observed in PA between IT, TS or PC organisational designs (Table 3).

[Table 3 near here]

Negative effect of challenge was present in skilled boys

There was no significant effect of skill level on the enjoyment reported in any type of organisational design (Table 4) and no significant effect of skill level on PA levels in any of the organisational designs for players identified as being at the structural stage (level 1) and the functional stage (level 2). A significant effect was identified for the PA levels in students belonging to the technical stage (higher skill level). In the IT organisational design, participants reported a higher PA level than in the PC organisational design (139.9 ± 39.8 counts vs. 94.2 ± 24.1 counts/sec, for the IT and PC organisational designs respectively, $p < .05$, ES = .82).

[Table 4 near here]

Discussion

The aim of this study was to assess how participant characteristics (sex, age and skill levels), interacted with the different formats of games in competitive badminton (e.g., *n* players, symmetric opposition) to influence their enjoyment and PA.

Organisational designs impact the amount of PA, but not the enjoyment experienced

Results showed that organisational designs had no significant influence on the enjoyment levels reported (ER). The high score values observed are congruent with data reported from previous studies, confirming badminton to be extremely popular with students. The ER values (5.3 ± 1.2) are slightly higher than those reported in the study of Deslauriers (4.8 ± 1.1; 2007) and higher than those noted during studies using table tennis as the sport (3.7 ± 1.0; Dieu, Joing and Drumez 2016). Despite no difference in enjoyment scores, results showed a significant effect of organisational designs on the amount of PA undertaken, with significantly lower values in PC than in TS. No difference was noted between IT and the other organisational designs. This finding is surprising according to existing literature that has mainly highlighted a positive correlation between enjoyment and PA (Bai et al. 2018). Moreover, the lack of differences between TS (team game) and IT (individual game) does not support the idea that using team game constitutes a key variable for increasing the PA of students in PE (Jaakkola et al. 2017; Zhou 2019).

Individual characteristics interact with organisational designs for the enjoyment and PA outcomes.

Sex differences interact with skill level

Results demonstrated that sex had no influence on the ER scores emerging from the three organisational designs. This result challenges common findings showing that girls prefer team organisational designs and boys prefer individual and competitive organisational designs (Azzarito and Solmon 2009). By contrast, our results are congruent with research on the Situational Interest framework, which proposes that sex is not a determinant of students' motivational responses to situational interest (Chen and Darst 2001). With regard to the amount of PA measured, sex impacted only on skilled male participants. In line with our previous

findings concerning enjoyment, the TS organisational design based on relationships in a team did not generate higher PA scores for female students in comparison to the other designs. In contrast, male students moved less in the PC than in the TS and IT organisational designs.

The interaction between age and organisational designs only impacts amount of PA.

Our results demonstrated that enjoyment scores were high and continued to be high in line with age in each badminton organisational design, for both boys and girls. Research suggests that motivation for engaging in PE declines with age (Trujillo et al. 2004), with an overall decline in female students' enjoyment during the first two years of secondary school (Dudley et al. 2013). In the present study, the level of enjoyment reported by participants was high, suggesting that older students (boys and girls) may still enjoy engaging in PE units, in the specific case of badminton lessons. Age had a significative impact on PA, however: young students moved less than older students (> 16 years) in the PC comparing to the TS organisational design. This result suggests that the interactions of individual (organismic) and task constraints can shape emergent outcomes, in terms of (more or less) PA while participants maintained a high level of enjoyment.

The skill level is a key variable for explaining pedagogical outcome in terms of ER and PA

Skill level did not impact the ER values regarding the three organisational designs, challenging the study of Vasconcellos et al. (2020). Nevertheless, the difference between the levels of ER of the most skilful students (stage 3), compared to the others, is almost statistically significant ($p = .052$), especially since this population is more restricted (10 vs 55) and the effect size can be considered as large (.51). Skill level had a significant impact on PA only for the most highly skilled students. With regard to the novice (stage 1) and the intermediate groups (stage 2), there was no significant difference observed in PA between the IT, TS, or PC organisational designs.

By contrast, students at stage 3 reported a significantly higher PA level in the IT than in the PC scenario. Finally, we cannot conclude that the PC organisational design is less engaging for all the participants. The “Challenge” disengages only skilled young men. This finding is new because it has been shown previously that young boys (Garrett 2004), especially the more skilful ones (Chen and Darst 2001), have more fun in PE and are more active as a result.

One explanation for this finding could be linked to an aspect that distinguishes the three badminton organisational designs: the question of the balance of power between the opponents during the task. In the IT or TS, the balance of power between the opponents is very balanced (symmetric duel). This feature contrasts with the PC organisational design, where the balance of power between the two players is artificially compensated by a handicap score system (non-symmetric duel). This environmental variable does not seem to compensate for the imbalance in the real balance of power between the 2 players. Our results suggested that an important effect of organisational design for games involves the manipulation of the balance of power that constrains the physical commitment made by skilled participants in badminton.

Our results converge towards the idea that the amount of enjoyment and PA observed in a PE badminton unit would benefit from being analysed, not only at an individual scale (Azzarito and Solmon 2009; Garrett 2004; Fairclough 2003; Trujillo et al. 2004; Zhou and Wang 2019), or at an environmental scale of analysis (Chen and Darst 2001; Roure and Pasco 2018; Lentillon-Kaestner and Patelli 2016; Zhou and Wang 2019), but by examining the interaction between organisational design for games and typology of students, implementing a CLA pedagogical framework.

Aligned with this theoretical challenge, investigating the effectiveness of interventions in PE settings to improve enjoyment and physical engagement, is a practical challenge for practitioners seeking to conceptualise the organisational design for games and play activities. Understanding how the CLA (Davids 2008; Renshaw et al. 2010; Rudd et al. 2020) could be

implemented in games teaching approaches (Bunker and Thorpe 1982; den Duyn 1997; Siedentop 2002) may be one way to investigate this possibility (Nathan 2016; Renshaw et al. 2016).

Regardless, our findings highlight the usefulness of using Motor Praxeology and CLA frameworks in a complementary manner for gaining a better understanding of how to mediate variations in participant engagement in PE activities. Our data suggest how the person environment scale analysis is facilitated by MP and its socio-motor classification considering that the inner structures of games can constrain participants and guide their continuous movement re-organisation. Motor communication networks to categorise sports and games (Parlebas 1996) induce three types of interactions between participants (environmental constraints) which influence the specific intentionality that individuals may attribute to the game (task constraint). This is particularly relevant for investigating the interactions of personal, task and environmental constraints on human behaviours. To summarise, our study shows potential benefits of linking MP and CLA pedagogical frameworks in order to enrich the organisational design of games to enhance physical activity in PE lessons. The MP framework provides a categorization system for the organisational design of learning and play activities, while the CLA framework provides a theoretical explanation of how task and environmental factors might be designed to interact with personal factors of individual learners to shape and enhance their enjoyment and PA experiences.

Limitations and future perspective

In this study, we did not measure the students' perceived physical ability that may also affect the enjoyment experienced in PE (Fairclough 2003). This research calls for caution with the use of enjoyment scales in PE classes because students could declare *post hoc* the same enjoyment levels in experiencing different organisational designs for games, while their PA

decreased significantly *during* one of them (here, PC). Therefore, a combined method including a quantitative PA measurement and a more qualitative "situational interest" declaration measurement (Roure and Pasco 2018) could be relevant for providing a more in-depth analysis of the effect of game formats in future research.

Implication for practitioners

To enrich learning experiences in PE, Motor Praxeology could support the CLA that challenges teachers to "effectively manipulate constraints, and particularly affects in learning design, to enhance the development of engagement in sport" (Headrick et al. 2015).

Our results showed the significant impact of different organisational designs (individual vs team competitions, matches with handicaps, etc.) on students' experiences in terms of physical engagement and perceived enjoyment, encouraging PE teachers to explore new game formats to engage students in an enjoyable physical activity. Our results also showed different effects depending on the age and level of expertise of the players, emphasising for teachers that an ideal practice format for all is not to be sought, but to be adapted according to individual profiles.

Conclusion

In undertaking an in-depth exploration of the effects of interactions between organisational design for games, goal tasks and students' characteristics, a combination of MP and CLA frameworks has enabled us to overcome some of the prevailing beliefs about pleasure and the commitment made by students in common physical education play and activity formats. The

results of our study showed that there is no ideal organisational design for engaging students, but the most productive formats depend on the specific interests of the students.

These findings provide an incentive for further developing empirical studies that enable the pedagogical innovations of PE teachers to be evaluated with a greater degree of accuracy. Improving the quality of physical education teaching, thus enabling all students to have physically and emotionally intense experiences, remains one of the most promising avenues for engaging future adults in an active and enjoyable lifestyle.

Declaration of interest statement

No potential conflict of interest was reported by the authors. The present study complies with the current laws of the country in which it was performed.

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