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Enriching organisational design for games: the case of badminton in physical education

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1 **Enriching organisational design for games: The case of Badminton in**
2 **Physical Education**

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23 **Abstract**

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

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

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

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

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

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

53

54

55 **Keywords: Enrichment, organisational design, physical education, physical activity,**
56 **Badminton.**

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60 **Enriching organisational design for games: The case of Badminton in Physical Education**

61 **Introduction**

62 At a time when sedentary lifestyles are a major concern raised in educational and public health
63 policies, formal Physical Education (PE) classes in many school syllabi provide an opportunity
64 to increase Physical Activity (PA) among adolescents (Somerset and Hoare 2018). However,
65 PE teachers may not succeed in achieving this goal if organisational design is not sufficiently
66 rich to engage students, especially those who are not spontaneously attracted to sport (Dudley
67 et al. 2011). To address this issue, school curricula can promote a high-quality PE programme,
68 based on enriched learning experiences stimulating participation in sports, exercise and
69 recreation (Rudd et al. 2020). Enriched learning designs contain a multitude of opportunities
70 for action which requires the integration of cognitive, emotional, social, perceptual and physical
71 dimensions of behaviour (Button et al. 2020, Rudd et al. 2020; Renshaw et al. 2010; Woods et
72 al. 2020). They are dynamic, challenging and enjoyable because they are focused on specific
73 learners' interests and needs (Headrick et al. 2015; Pinder et al. 2011; Renshaw et al. 2016).
74 Amongst the positive benefits of such designs, research has emphasised that enjoyment is one
75 of the best predictors for promoting PA inside the school setting (Lonsdale 2013; Jaakkola et
76 al. 2017). Yet further research is needed to investigate the effectiveness of interventions in PE
77 settings to improve enjoyment and physical engagement (Dudley et al. 2011). Coupling the
78 Constraint Led Approach to skill acquisition (Davids 2008; Renshaw et al. 2010; Rudd et al.
79 2020) and Motor Praxeology (Parlebas 1999) provide an interesting theoretical approach to this
80 practical challenge, as they capture how to enrich learning experience in sport and PE and
81 appear operational for categorizing sport tasks (Martínez-Santos et al. 2020).

82 ***Contribution of the Constraint Led Approach: A Holistic Framework for Measuring***83 ***Interactive Effects in Learning Design***

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

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

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

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

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

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

143 **[Figure 1 near here]**

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

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

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

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

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

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

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

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

194 **Purpose of the study**

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

199 **Materials and methods**

200 *Participants*

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

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

217 **[Table 1 near here]**

218 These indicators were related to the participants' expertise levels, derived from the three
219 components described in the conative framework: the physical component based on the length
220 of rallies (Dieu et al. 2020), the tactical component with the shuttlecock trajectories and the
221 observed ratio between forced and non-forced errors (Laffaye, Phomsoupha and Dor 2015) and
222 the technical component with the observation of arm and trunk actions in overhead forehand
223 strokes (Wang, Liu and Moffit 2009). Pre-intervention data collected during the first lesson
224 revealed that the participants were categorised in the three first stages of the conative model:
225 24 novices (first conative stage), 21 at an intermediate level (second stage) and 10 more skilled
226 (third conative stage). In accordance with French law and the European regulation on data
227 protection, an authorisation was registered by the ethical board of the Littoral Opal Coast

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

230 *Design of badminton unit and description of organisational design*

231 **[Figure 2 near here]**

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

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

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

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

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

271 *Standardisation of interventions*

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

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

285 *Data collection*

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

295 *Data measurement*

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

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

306 *Statistical analysis*

307 For all quantitative variables (Enjoyment Reported score (ER) and PA) mean and standard
308 deviation were calculated. Qualitative variables (sex, age and conative level) were described in
309 terms of frequency and percentage. Normality and sphericity of the repeated measures data
310 were assessed by the Shapiro-Wilk's and Mauchley's tests. The effect of the learning design on
311 PA and ER was measured using a linear mixed model, with simple effect tests, including PA
312 or ER as a dependent variable to explain effects of the type of learning design, ability levels,
313 age, and sex (fixed effect), the student and the interaction term: student * type of learning design
314 were modelled as random effects. Post-hoc comparisons between the types of learning design
315 were performed by correcting the risk of a type I error using the Bonferroni method. Bilateral
316 tests were performed with a statistical significance level of 5%. Statistical analyses were
317 performed using SAS software (SAS Institute version 9.4). Magnitudes of all the significant
318 differences were examined using effect size (ES) calculations with Cohen's recommendations
319 (1988) to consider the effect small when $\eta^2 > .01$, medium when $\eta^2 > .06$ and large when $\eta^2 > .14$.
320

321 **Results**

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

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

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

331 **[Table 2 near here]**

332

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

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

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

343 *Negative effect of challenge was present among young students*

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

350 **[Table 3 near here]**

351 *Negative effect of challenge was present in skilled boys*

352 There was no significant effect of skill level on the enjoyment reported in any type of
353 organisational design (Table 4) and no significant effect of skill level on PA levels in any of
354 the organisational designs for players identified as being at the structural stage (level 1) and the
355 functional stage (level 2). A significant effect was identified for the PA levels in students
356 belonging to the technical stage (higher skill level). In the IT organisational design, participants
357 reported a higher PA level than in the PC organisational design (139.9 ± 39.8 counts vs. $94.2 \pm$
358 24.1 counts/sec, for the IT and PC organisational designs respectively, $p < .05$, $ES = .82$).

359 **[Table 4 near here]**

360

361 **Discussion**

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

365

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

367 Results showed that organisational designs had no significant influence on the enjoyment levels
368 reported (ER). The high score values observed are congruent with data reported from previous
369 studies, confirming badminton to be extremely popular with students. The ER values ($5.3 \pm$
370 1.2) are slightly higher than those reported in the study of Deslauriers (4.8 ± 1.1 ; 2007) and
371 higher than those noted during studies using table tennis as the sport (3.7 ± 1.0 ; Dieu, Joing and
372 Drumez 2016). Despite no difference in enjoyment scores, results showed a significant effect
373 of organisational designs on the amount of PA undertaken, with significantly lower values in
374 PC than in TS. No difference was noted between IT and the other organisational designs. This
375 finding is surprising according to existing literature that has mainly highlighted a positive
376 correlation between enjoyment and PA (Bai et al. 2018). Moreover, the lack of differences
377 between TS (team game) and IT (individual game) does not support the idea that using team
378 game constitutes a key variable for increasing the PA of students in PE (Jaakkola et al. 2017;
379 Zhou 2019).

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

382 ***Sex differences interact with skill level***

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

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

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

394 Our results demonstrated that enjoyment scores were high and continued to be high in line with
395 age in each badminton organisational design, for both boys and girls. Research suggests that
396 motivation for engaging in PE declines with age (Trujillo et al. 2004), with an overall decline
397 in female students' enjoyment during the first two years of secondary school (Dudley et al.
398 2013). In the present study, the level of enjoyment reported by participants was high, suggesting
399 that older students (boys and girls) may still enjoy engaging in PE units, in the specific case of
400 badminton lessons. Age had a significant impact on PA, however: young students moved less
401 than older students (> 16 years) in the PC comparing to the TS organisational design. This result
402 suggests that the interactions of individual (organismic) and task constraints can shape
403 emergent outcomes, in terms of (more or less) PA while participants maintained a high level of
404 enjoyment.

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

406 *PA*

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

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

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

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

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

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439 implemented in games teaching approaches (Bunker and Thorpe 1982; den Duyn 1997;
440 Siedentop 2002) may be one way to investigate this possibility (Nathan 2016; Renshaw et al.
441 2016).

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

458

459 **Limitations and future perspective**

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

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

468

469 **Implication for practitioners**

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

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

480

481 **Conclusion**

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

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

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

493

494 **Declaration of interest statement**

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

497

498 **References**

499 Azzarito, L., and M. Solmon. 2009. « An Investigation of Students' Embodied Discourses in
500 Physical Education: A Gender Project. » *Journal of Teaching in Physical Education* 28
501 (2): 173-191. doi:[10.1123/jtpe.28.2.173](https://doi.org/10.1123/jtpe.28.2.173).

502 Bai, Y., K. Allums-Featherston, P. F. Saint-Maurice, G. J. Welk, and N. Candelaria. 2018.
503 « Evaluation of Youth Enjoyment Toward Physical Activity and Sedentary Behavior. »
504 *Pediatric Exercise Science* 30 (2): 273-280. doi:[10/gkq8fb](https://doi.org/10/gkq8fb).

505 Barker, D., H. Larsson, and G. Nyberg. 2019. « Joy, fear and resignation: Investigating
506 emotions in physical education using a symbolic interactionist approach. » *Sport,*
507 *Education and Society* 25 (8) : 872-888. doi [10.1080/13573322.2019.1672148](https://doi.org/10.1080/13573322.2019.1672148).

508

ENRICHED LEARNING DESIGN

- 509 Bunker, D., and R. Thorpe. 1982. « A model for the teaching of games in secondary schools.
510 Bulletin of physical education. » *Bulletin Physical Education* 18(1): 5–8.
- 511 Button, C., L. Seifert, J.-Y. Chow, D. Araújo, and K. Davids. 2020. *Dynamics of Skill*
512 *Acquisition: An Ecological Dynamics Rationale*. Champaign, IL: Human Kinetics.
- 513 Chen, A., and P. W. Darst. 2001. « Situational Interest in Physical Education: A Function of
514 Learning Task Design. » *Research Quarterly for Exercise and Sport* 72 (2): 150-164.
515 doi:[10.1080/02701367.2001.10608945](https://doi.org/10.1080/02701367.2001.10608945).
- 516 Cohen, J. 1988. *Statistical power analysis for the behavioral sciences*. 2nd ed. Hillsdale: L.
517 Erlbaum Associates.
- 518 Davids, K., C. Button, and S. J. Bennett. 2008. *Dynamics of Skill Acquisition: A Constraints-*
519 *Led Approach*. Champaign: Human Kinetics.
- 520 Delignières, D., and S. Perez. 1998. « Le plaisir perçu dans la pratique des APS: élaboration
521 d'un outil d'évaluation [Perceived pleasure in Physical Activity: development of an
522 evaluation tool]. » *Staps* 45: 7-18.
- 523 den Duyn, N. 1997. *Game Sense – Developing Thinking Players – a presenters guide and*
524 *workbook*. Belconnen, Canberra: Australian Sports Commission.
- 525 Deslaurier, S. 2007. « Plaisir perçu en E.P.S. : quels liens avec la motivation des élèves?
526 [Perceived pleasure in PE: which links with pupil motivation?]. » In *Pupils' enjoyment in*
527 *physical education and sport: futility or necessity?* edited by Philippe Gagnaire and
528 François Lavie, 101-114. Paris: AEEPS.
- 529 Dieu, O., I. Joing, and E. Drumez. 2016. « Teaching practices and symbolic violence: The case
530 of racket sports at school ». *Staps* 112 (2): 85-98. doi:[10.3917/sta.112.0085](https://doi.org/10.3917/sta.112.0085).
- 531 Dieu, O., and C. Llena. 2019. « Influence de la « coloration émotionnelle » des typologies de
532 pratique sur l'implication physique des élèves lors d'un cycle de badminton en EPS
533 [Impact of the “emotional coloration” of the different types of practice on the physical

ENRICHED LEARNING DESIGN

- 534 engagement of students during a PE badminton unit]. » *Teaching PE*, Édition AE-EPS, 5
535 (1): 38-42.
- 536 Dieu, O., C. Schnitzler, C. Llana, and F. Potdevin. 2020. « Complementing Subjective with
537 Objective Data in Analysing Expertise: A Machine-Learning Approach Applied to
538 Badminton. » *Journal of Sports Sciences* 38 (17): 1943-1952. doi:[10/ghfx5d](https://doi.org/10.ghfx5d).
- 539 Dudley, D., A. D. Okely, P. Pearson, and W. A. Cotton. 2011. « A Systematic Review of the
540 Effectiveness of Physical Education and School Sport Interventions Targeting Physical
541 Activity, Movement Skills and Enjoyment of Physical Activity. » *European Physical
542 Education Review* 17 (3): 353-378. doi:[10/frk9xm](https://doi.org/10/frk9xm).
- 543 Fairclough, S. 2003. « Physical Activity, Perceived Competence and Enjoyment During High
544 School Physical Education. » *Physical Education & Sport Pedagogy* 8 (1): 5-18.
545 doi:[10.1080/1740898030080102](https://doi.org/10.1080/1740898030080102).
- 546 Garrett, R. 2004. « Negotiating a Physical Identity: Girls, Bodies and Physical Education. »
547 *Sport, Education and Society* 9 (2): 223-237. doi:[10.1080/1357332042000233958](https://doi.org/10.1080/1357332042000233958).
- 548 Headrick, J., I. Renshaw, K. Davids, R. A. Pinder, and D. Araújo. 2015. « The Dynamics of
549 Expertise Acquisition in Sport: The Role of Affective Learning Design. » *Psychology of
550 Sport and Exercise* 16: 83-90. doi:[10/f6wh95](https://doi.org/10/f6wh95).
- 551 Jaakkola, T., S. Yli-Piipari, V. Barkoukis, and J. Liukkonen. 2017. « Relationships among
552 Perceived Motivational Climate, Motivational Regulations, Enjoyment, and PA
553 Participation among Finnish Physical Education Students. » *International Journal of
554 Sport and Exercise Psychology* 15 (3): 273-290. doi:[10/gnktqk](https://doi.org/10/gnktqk).
- 555 Laffaye, G., M. Phomsoupha, and F. Dor. 2015. « Changes in the Game Characteristics of a
556 Badminton Match: A Longitudinal Study through the Olympic Game Finals Analysis in
557 Men's Singles. » *Journal of sports science & medicine* 14 (3): 584-592.

ENRICHED LEARNING DESIGN

- 558 Lentillon-Kaestner, V., and G. Patelli. 2016. « Effects of Grouping Forms, Student Gender and
559 Ability Level on the Pleasure Experienced in Physical Education. » *Journal of Teaching*
560 *in Physical Education* 35 (3): 251-262. doi:[10.1123/jtpe.2014-0216](https://doi.org/10.1123/jtpe.2014-0216).
- 561 Light, R. (2003). « The joy of learning: Emotion and learning in games through TGfU ». *New*
562 *Zealand Physical Educator* 36 (1), 93-109.
- 563 Lonsdale, C., R. Rosenkranz, L. R. Peralta, A. Bennie, P. Fahey, and D. R. Lubans. 2013. « A
564 Systematic Review and Meta-Analysis of Interventions Designed to Increase Moderate-
565 to-Vigorous Physical Activity in School Physical Education Lessons. » *Preventive*
566 *Medicine* 56 (2): 152-161. doi:[10/f4m5j4](https://doi.org/10/f4m5j4).
- 567 Martínez-Santos, R., M. Pilar Founaud, A. Aracama, and A. Oiarbide. 2020. « Sports Teaching,
568 Traditional Games, and Understanding in Physical Education: A Tale of Two Stories. »
569 *Frontiers in Psychology* 11: 581-592. doi:[10.3389/fpsyg.2020.581721](https://doi.org/10.3389/fpsyg.2020.581721).
- 570 Nathan, S. 2016. « Badminton instructional in Malaysian schools: a comparative analysis of
571 TGfU and SDT pedagogical models. » *SpringerPlus* 5(1): 12-15. doi:[10.1186/s40064-](https://doi.org/10.1186/s40064-016-2872-3)
572 [016-2872-3](https://doi.org/10.1186/s40064-016-2872-3).
- 573 Parlebas, P. 1981, *Lexique commenté en science de l'action motrice*. Paris :
574 INSEP.
- 575 Parlebas, P. 1996. *Éléments de sociologie du sport*. Paris: Presses Universitaire de France.
- 576 Parlebas, P. 1999. *Jeux, sports et sociétés: Lexique de praxéologie motrice*. Paris: Presses
577 Universitaire de France.
- 578 Peters, S., and R. Norton, R. 2018. Sex and gender reporting in global health: new editorial
579 policies. *BMJ global health*, 3(4), e001038. doi: [10.1136/bmjgh-2018-001038](https://doi.org/10.1136/bmjgh-2018-001038)
- 580 Pinder, R. A., K. Davids, I. Renshaw, and D. Araújo. 2011. « Representative Learning Design
581 and Functionality of Research and Practice in Sport. » *Journal of Sport and Exercise*
582 *Psychology* 33 (1): 146-155. doi:[10/gf4md7](https://doi.org/10/gf4md7).

ENRICHED LEARNING DESIGN

- 583 Renshaw, I., J. Y. Chow, K. Davids, and Hammond J. 2010. « A constraints-led perspective to
584 understanding skill acquisition and game play: a basis for integration of motor learning
585 theory and physical education praxis? » *Physical Education and Sport Pedagogy*, 15:2,
586 117-137. doi:[10.1080/17408980902791586](https://doi.org/10.1080/17408980902791586).
- 587 Renshaw, I., D. Araújo, C. Button, J. Y. Chow, K. Davids, and B. Moy. 2016. « Why the
588 Constraints-Led Approach Is Not Teaching Games for Understanding: A Clarification. »
589 *Physical Education and Sport Pedagogy* 21 (5): 459-80. doi:[10/ghfx4z](https://doi.org/10/ghfx4z).
- 590 Rink J. E., K. French, and B. L. Tjeerdsma. 1996. « Foundation for the learning and instruction
591 of sport and games. » *Journal of Teaching in Physical Education*. 15 (4):399–417.
592 doi:[10.1123/jtpe.15.4.399](https://doi.org/10.1123/jtpe.15.4.399).
- 593 Roure, C., and D. Pasco. 2018. « The Impact of Learning Task Design on Students' Situational
594 Interest in Physical Education. » *Journal of Teaching in Physical Education* 37 (1):
595 24-34. doi:[10.1123/jtpe.2017-0046](https://doi.org/10.1123/jtpe.2017-0046).
- 596 Rudd, J. R., C. Pesce, B. W. Strafford, and K. Davids. 2020. « Physical Literacy - A Journey
597 of Individual Enrichment: An Ecological Dynamics Rationale for Enhancing
598 Performance and Physical Activity in All » *Frontiers in Psychology* 11: 1904-1911.
599 doi:[10/ghfx45](https://doi.org/10/ghfx45).
- 600 Siedentop, D. 2002. « Sport Education: A Retrospective ». *Journal of Teaching in Physical*
601 *Education* 21(4): 409-418. doi:[10.1123/jtpe.21.4.409](https://doi.org/10.1123/jtpe.21.4.409).
- 602 Somerset, S., and D. J. Hoare. 2018. « Barriers to voluntary participation in sport for children:
603 A systematic review. » *BMC Pediatrics*, 18(1), 1-19. doi:[10.1186/s12887-018-1014-1](https://doi.org/10.1186/s12887-018-1014-1).
- 604 Tan C. W., J. Y. Chow, and K. Davids. 2012. « How does TGfU work?': examining the
605 relationship between learning design in TGfU and a nonlinear pedagogy. » *Physical*
606 *Education & Sport Pedagogy* 17(4): 331–348. doi:[10.1080/17408989.2011.582486](https://doi.org/10.1080/17408989.2011.582486).

ENRICHED LEARNING DESIGN

- 607 Trujillo, K. M., R. R. Brougham, and D. A. Walsh. 2004. « Age Differences in Reasons for
608 Exercising. » *Current Psychology* 22 (4): 348-67. doi:[10.1007/s12144-004-1040-z](https://doi.org/10.1007/s12144-004-1040-z).
- 609 Vasconcellos, D., P. D. Parker, T. Hilland, R. Cinelli, K. B. Owen, N. Kapsal, J. Lee, et al.
610 2020. « Self-Determination Theory Applied to Physical Education: A Systematic Review
611 and Meta-Analysis. » *Journal of Educational Psychology* 112 (7): 1444-1469.
612 doi:[10/gk6htx](https://doi.org/10/gk6htx).
- 613 Yeh, H-P., J. Stone, S. Churchill, J. Wheat, E. Brymer, and K. Davids. 2016. « Benefits of green
614 physical activity: An ecological dynamics perspective. » *Sports Medicine* 46:947-953.
615 doi:[10.1007/s40279-015-0374-z](https://doi.org/10.1007/s40279-015-0374-z).
- 616 Wang, J., W. Liu, and J. Moffit. 2009. « Steps for ARM and trunk actions of overhead forehand
617 stroke used in badminton games across skill levels. » *Perceptual and Motor Skills* 109
618 (1): 177–186. doi:[10.2466/PMS.109.1.177-186](https://doi.org/10.2466/PMS.109.1.177-186).
- 619 Woods, C. T., J. Rudd, S. Robertson, and K. Davids (2020). Wayfinding: how ecological
620 perspectives of navigating dynamic environments can enrich our understanding of the
621 learner and the learning process in sport. *Sports Medicine Open* 6:51.
622 doi :[10.1186/s40798-020-00280-9](https://doi.org/10.1186/s40798-020-00280-9).
- 623 Zhou, Y., and L. Wang. 2019. « Correlates of Physical Activity of Students in Secondary
624 School Physical Education: A Systematic Review of Literature. » *BioMed Research*
625 *International* 2: 1-12. doi:[10/gnktqn](https://doi.org/10/gnktqn).
- 626
- 627
- 628
- 629