Self-made material in physical education: Teacher perceptions of the use of an emerging pedagogical model before and during the COVID-19 pandemic

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Abstract
The COVID-19 pandemic caused drastic changes in education, which had to adapt to changing scenarios (online, face-to-face, hybrid teaching). Within physical education (PE), strategies such as ‘do not use or share equipment’ were proposed to avoid infections. These strategies fit with an emerging pedagogical model called the Self-made Material Model (SMM), which involves students creating their own PE equipment. The objectives of the present study were: (a) to analyse PE teachers’ beliefs about the use of self-made material in their classes, (b) to evaluate teachers’ perceptions of the impact of the use of self-made material in PE lessons during the pandemic and (c) to examine gender/age differences. A quantitative, snowball research design was followed. The Self-made Material Questionnaire (Méndez-Giménez and Fernández-Río, 2011) comprising two scales (41 items) was adapted:

1. Teachers’ beliefs about the use of self-made material scale
2. Teachers’ perceptions of the impact of self-made material usage during the pandemic scale

In total, 1093 in-service teachers (443 women, 40.5%; $M = 41.39$, $SD = 9.54$) from 13 Ibero-American countries participated. Descriptive statistics were calculated, Student’s $T$ test was conducted for comparisons by gender and one-way analysis of variance (ANOVA) was run for comparisons by age ranges. Overall, the scores were high, emphasising the potential to promote recycling and students’ creativity and respect for the material.
scored higher in items such as promoting interdisciplinarity, equality, attention to disability and education in values. In total, 833 (76.21%) teachers used self-made material during the pandemic and reported high levels of satisfaction, expectations of use, usefulness and profitability. No gender differences were found. In the COVID-19 era, the SMM is playing a relevant role as a meaningful framework and a helpful teaching methodology in different educational scenarios.

Keywords
Sustainable development, recycling, constructionism, physical education, pandemic, COVID-19, pedagogical model

Introduction
Changes in the teaching of physical education during the COVID-19 pandemic
The COVID-19 pandemic caused drastic changes in education: confinement at home, online education, social distancing, mobility and social restrictions (Sá and Serpa, 2020). In April 2020, a total of 138 countries closed their schools, resulting in educational disruption for approximately 80% of children worldwide (Van Lancker and Parolin, 2020). Since then, education has had to adapt to changing scenarios depending on the evolution of the pandemic, from face-to-face learning with strict protocols (e.g. bubble groups, delimited spaces, use of masks, constant cleaning of hands and material, no sharing material) to online or distance learning (not face-to-face), through hybrid education (in its two variants: either online or face-to-face, or one part of the group at home and the other in person). The sustainability of effective learning was identified as a major challenge at all educational levels (Zhang et al., 2020).

Due to the special features of physical education (PE) (it requires performing physical activity and learning motor skills using specific equipment in sports facilities), practical lessons, in their online version, are neither easy for teachers to teach, nor clear for students to learn from (Yu and Jee, 2021). Educational institutions were concerned about the limited diversity of PE content delivered through online learning environments (O’Brien et al., 2020). The significant decrease in the active part of the PE class was considered a serious threat to the basic objectives of the subject, as well as to the quality of PE – which is based on equal opportunities for all students to access a balanced and inclusive curriculum (Adamakis, 2021). PE lessons underwent some changes: individual activities over group ones, more personal space around each student, limited physical contact and modifications in the role of the teacher (Varea and González-Calvo, 2021; Varea et al., 2022).

Among other alternative strategies to implementing PE during the COVID-19 pandemic, it was proposed that students either brought material from home or did not use any equipment (Fíliz and Konukman, 2020). A more challenging strategy involves them in the development of didactic materials from recycled material (COLEF Council, 2020). The didactic materials are frequently understood as the instruments used by teachers to facilitate and guide student learning (e.g. sports equipment). This strategy fits with an emerging pedagogical model called the Self-made Material Model (SMM; Fernández-Río et al., 2016).

Self-made material in PE: Background, rationale and structural elements of an emerging pedagogical model
The idea of employing used or old materials to craft new equipment for PE or leisure is not new. Pearson (1973) called them inexpensive and innovative. Others described them as improvised
inexpensive or low cost (Jackson and Bowerman, 2009; Werner and Simmons, 1990), but most scholars refer to these materials as homemade material or equipment (Davis, 1979). All these authors supported the idea that non-traditional (Maeda and Burt, 2003), thrown away (Corbin and Corbin, 1983), found (Davis, 1979) or recycled materials (Grigg, 2009) are not difficult to adapt and use in PE (Moss, 2004).

Many authors believed that homemade equipment should be constructed by those teachers who feel that they need extra materials to enhance their PE programmes (Bradtke, 1979; Davis, 1979; Jackson and Bowerman, 2009; Maeda and Burt, 2003; Moss, 2004). Others considered that these materials could be constructed by both teachers and students alike depending on how difficult the construction process seems to be (Corbin and Corbin, 1983; Grigg, 2009; Marston, 1994; Pearson, 1973; Werner and Simmons, 1990).

The SMM involves students in the collection, recycling, handling and transformation of raw and homemade materials (e.g. cardboard, plastic bags or newspaper), as well as other generally low-cost objects (e.g. balloons, adhesive tape or Velcro) to develop teaching materials that are used in the learning of theoretical and practical content of subjects (Méndez-Giménez, 2021). In the case of PE, their use aims at the production of resources (mobiles, implements and goals) for learning all subject content (e.g. body scheme, basic skills, corporal expression, physical condition, games and sports, outdoor activities) at any stage and educational level (Méndez-Giménez, 2014). Some examples of self-made materials are cardboard ‘ringos’, baseball bats made of newspapers, balls made of milk bottles and petekas/indiacas (shuttlecocks) made of plastic bags or rackets made of wire hangers. The SMM has been related to the development of ecological awareness, both in PE students and in the educational community, and conceived as an ideal tool to develop students’ cooperation and creativity (Fernández-Río and Méndez-Giménez, 2012, 2014).

In addition, the SMM has been considered a suitable model to connect and hybridise with other pedagogical models, such as cooperative learning (Fernández-Río and Méndez-Giménez, 2012, 2014; Rodríguez-Martínez et al., 2021), tactical games model (Méndez-Giménez, 2014), sport education (Méndez-Giménez et al., 2015, 2016b) or inventing games (Fernández-Río and Méndez-Giménez, 2014; Hastie and André, 2012).

The process of construction fosters the five critical elements of cooperative learning in PE (Fernández-Río and Méndez-Giménez, 2012). When students are asked to build a piece of equipment in small groups, they are guided into a face-to-face interaction process. Consequently, interpersonal skills are developed through group processing in order to solve possible problems. Moreover, the challenge of the task is individually accountable as students must create low-cost, efficient equipment for the group. Finally, this context helps develop positive interdependence among students when they play different roles (such as builder or presenter).

Furthermore, the SMM approach can strengthen and complement the tactical games model by means of modification, representation and diversification (Fernández-Río and Méndez-Giménez, 2014; Méndez-Giménez, 2014). First, it is possible to produce materials that both fit the developmental needs of students better than marketed materials (smaller, lighter or softer) and, at the same time, simplify their technical demands. Second, the SMM allows the diversification of games from the same tactic category, which will facilitate tactical learning generalisation (Méndez-Giménez, 2014).

Moreover, the construction of materials can reinforce the sport education model in three ways (Méndez-Giménez, 2014; Méndez-Giménez et al., 2015, 2016b). First, it can contribute to the development of small-sided games that fit the needs of the participants. Second, students could also make flags, shields, banners or shirts representing their team during the season. All these actions reinforce team affiliation. Third, it can enhance the representative festive atmosphere of
this model. For instance, each group could build a trophy that will be awarded at the end of the unit to emphasise different individual or collective values (e.g. fair play, effort).

Finally, the SMM could complement the framework of inventing games and provide a more relevant range of experiences through low-cost materials (Méndez-Giménez, 2014; Méndez-Giménez and Fernández-Río, 2012). Students could also be challenged to invent different uses and/or games with these new available resources (Hastie and André, 2012).

Two theoretical frameworks conceptually support the SMM and are shared by the aforementioned pedagogical models. On the one hand, constructionism enables students to build their own inner knowledge thanks to the construction of artefacts (implements and mobiles) that they socially use (Papert, 1987, 1996; Papert and Harel, 1991). Learning is more robust and fruitful if the student is consciously involved in a public construction, a craft that can be shown, discussed, examined, verified, or admired (Papert, 1987). Students develop their knowledge creating, experimenting with, modifying and analysing the potentialities of these artefacts. Constructionism gives learners an active role in their learning. When the students attempt to design and build their objects, they face dilemmas to solve, as well as meaningful decisions to make (Papert, 1987). Furthermore, the model emphasises the three facets of constructivism (Perkins, 1999): (a) the active learner: the student is actively involved in the design, transformation and verification of the artefact; (b) the social learner: the student constructs, experiences and evaluates the artefact in a social context; and (c) the creative learner: the student engages in artefact design, developing imagination and generating divergent processes.

In addition to constructionism, Méndez-Giménez (2014) pointed out five more structural elements of this model:

1. **Holistic process.** The self-made material approach has the potential to challenge the learner as a whole and to develop the different domains of the individual (cognitive, physical, artistic, affective and social) within the same integral project. Therefore, this framework can be seen as an interesting way to address interdisciplinary projects, as well as multiple key competences (e.g. learning to learn, social and civic, autonomy and personal initiative).

2. **Functionality.** This perspective also helps to solve a prevalent problem within PE classes: the scarcity of resources due to limited budgets. Hardman (2008) reported that 50% of PE teachers evaluated worldwide considered that the quantity of their PE materials was ‘limited’ or ‘insufficient’. The quantity and quality of a school’s equipment can detrimentally influence the excellence of its PE curriculum. Moreover, the restrictions imposed by insufficient equipment are constant sources of frustration for teachers (O’Really et al., 2001). Furthermore, discipline and behavioural problems often appear when students have to wait in line for long periods of time because of a limited number of resources (Werner and Simmons, 1990).

3. **Involvement.** The constructivist paradigm emphasises the need to involve students in their own learning process (see the three tenets of constructivism: active, social and creative learner in Perkins, 1999). Self-made equipment will allow each student to have his or her own piece of equipment, thus maximising involvement and participation. Every student would have many opportunities to explore a wide variety of movement patterns and experience many different physical activities in and out of school.

4. **Autonomy.** Having enough materials can help students increase their motor experiences in PE and prolong free and autonomous physical activity practice in the school context. Learners often find it difficult to practice PE content in their leisure time due to financial
barriers and the lack of materials (Hulteen et al., 2017). The SMM breaks the dependency cycle of school materials and provides students with resources to undertake extracurricular activities.

5. Values education. Finally, this educational approach aims to develop students’ values and attitudes. Values such as recycling, respect for the environment, respect for own and others’ goods, consumer education, or the promotion of an open mind to share artefacts are emphasised in this model. The idea of raising ecological awareness in the school community (e.g. students, teachers and parents) through the recycling of materials and their use in class is also promoted (Chen, 2016; Chen and Breeding, 2022). Marston (1994) pointed out that children might become more sensitive and responsible to environmental concerns if they learn to make a connection between improvised equipment and their enjoyment of movement. Thus, the goal would be to increase students’ consciousness about the physical environment so that they could become sustainability orientated (Grigg, 2009).

Related to this last structural element, the SMM has also been connected to the goals established by the United Nations to take care of the planet and guarantee the prosperity of all citizens (United Nations, 2015a). They are grouped into 17 Sustainable Development Goals (SDGs), which are, in turn, divided into 169 specific targets that detail each of the SDGs (United Nations, 2015b). A recent study concluded that of the 169 specific targets proposed in the SDGs, 24 could be worked on in PE (Baena-Morales et al., 2021b). For these authors, the SMM could contribute to the achievement of target 4.7 (Improving knowledge to promote global education for sustainable development), goals 12.1 (Implement the sustainable consumption and production framework), 12.2 (Sustainable management and use of natural resources), 12.5 (Prevention, reduction, recycling and reuse of waste), 12.8 (Ensure education for sustainable development) and goals 13.1 and 13.3 that, in general, defend the importance of respect for the environment. For example, in relation to SDG 4, the SMM considers PE as an opportunity to create self-made materials and to design alternative games/sports that reuse sport equipment for a purpose other than its original one (Fernández-Río and Méndez-Giménez, 2014). SDG 12 connects with the SMM when teachers promote activities to recycle or recover daily waste products that usually end up in the garbage (such as plastic bottles or packaging). Some examples could be a garbage sweep after recess to collect bags and waste to deposit in the corresponding containers, or a plogging activity where participants jog through different environments while collecting waste. Finally, SDG 13 is related to the SMM when considering environmental care as one of the main content areas.

Research on the SMM

Research has shown that the application of the SMM increases: (a) interest, fun and enthusiasm of primary and secondary school PE students (García-Romero, 2016; Méndez-Giménez et al., 2010, 2016b); (b) the intention to be physically active in PE lessons and outside school; (c) the perception of basic psychological needs: competence, relatedness and autonomy (Méndez-Giménez et al., 2016a, 2016b); (d) students’ physical self-concept (Fernández-Río et al., 2013); and (e) their levels of physical activity, self-determined motivation, general self-esteem and positive mood states during recess even in the context of the pandemic (Méndez-Giménez and Chamorro-Durán, in press; Méndez-Giménez and Pallasá, 2018; Méndez-Giménez et al., 2017). Research on Physical Education Teacher Education (PETE) students’ beliefs has revealed various educational benefits of the SMM such as students’ active commitment, inclusion and attention to diversity, and education in values (environmental education, ecological awareness about
waste and recycling, the development of creativity and respect for one’s own and others’ material) (Fernández-Río and Méndez-Giménez, 2013; Fernández-Río et al., 2014; Méndez-Giménez and Fernández-Río, 2010, 2011, 2012, 2013; Méndez-Giménez et al., 2016a, 2016b).

Previous research also found some gender differences regarding PETE students’ perceptions of self-made material. On the one hand, more women than men perceived that self-made material allowed them to work on shared objectives with other subjects and required greater teacher commitment (Méndez-Giménez and Fernández-Río, 2013). On the other hand, Fernández-Río et al. (2014) reported that sports science degree students in Portugal emphasised that the self-made materials ‘fitted very well with their way of learning’. The authors pointed out that women seem to have greater sensitivity towards this type of educational resource, perhaps because they consider themselves more able to build them and because these resources are closer to their likes, interests and hobbies. Since there is no previous research, it seems plausible to analyse whether these gender differences observed in PETE students also emerge among in-service teachers.

Although we have some evidence of the effect of the SMM in primary, secondary and PETE students (Méndez-Giménez, 2013), there is a research gap regarding in-service teachers’ perceptions of the use of this model, especially during the critical period of the pandemic. Considering teachers’ beliefs about the SMM is important, not only to address the pandemic restrictions, but also to increase student engagement during lessons.

**Objectives and hypotheses**

Taking into account the background described, the study set three objectives: (a) to analyse PE teachers’ beliefs about and perceptions of the use of self-made material in their lessons; (b) to evaluate their perceptions of the impact of the use of self-made material in PE lessons during the pandemic (in any of the three aforementioned scenarios); and (c) to examine possible differences based on gender or age.

The following hypotheses were formulated:

**Hypothesis 1.** Several studies showed that Spanish teacher education students (Fernández-Río and Méndez-Giménez, 2013; Méndez-Giménez and Fernández-Río, 2013) and Portuguese students enrolled in a Master’s program on teaching (Méndez-Giménez et al., 2016a) positively valued the use of self-made material as a pedagogical tool, as an interdisciplinary strategy, to educate on values, as a method to attend to schools’ diversity and as an assessment tool. Based on this evidence, it was predicted that in-service teachers would also value the use of these resources in similar terms.

**Hypothesis 2.** Previous research found gender differences regarding PETE students’ perceptions of self-made materials (Fernández-Río et al., 2014; Méndez-Giménez and Fernández-Río, 2013). Based on these studies, it was hypothesised that in-service women teachers would more highly value some aspects of this methodology: interdisciplinarity, education in values and assessment.

**Hypothesis 3.** Research showed that the application of the SMM increases students’ motivational levels both in the context of PE (García-Romero, 2016; Méndez-Giménez et al., 2010, 2016a, 2016b) and during recess (Méndez-Giménez and Chamorro-Durán, in press; Méndez Giménez and Pallasá, 2018; Méndez-Giménez et al., 2017). Based on this evidence, it was hypothesised that participants would positively assess the effects of the use of self-made material during the pandemic, both for the teacher themselves and for the students.

Finally, given the scarcity of research on this topic, hypotheses 4 and 5 were proposed in the following terms:
Hypothesis 4. There would be no gender differences in the teachers’ perceptions of the use of self-made material during the pandemic.

Hypothesis 5. There would be no significant age differences in any of the scales.

Methods

Participants

A sample of 1093 (443 women, 40.5%) in-service teachers, aged between 20 and 70 years ($M_{age} = 41.39$, $SD = 9.54$) of all educational stages from 17 Ibero-American countries participated. In-service university teachers were also included.

Design and procedure

Ethical approval was obtained in accordance with the Declaration of Helsinki (Asociación Médica Mundial, 2013). To gather data, the research team developed an online questionnaire using Google Forms. To recruit the participants, non-probabilistic ‘snowball’ sampling was used (Kosinski et al., 2015). The questionnaire was distributed through social networks (Facebook, Twitter, WhatsApp, YouTube and email) to a first wave of participants. They were asked to distribute it among their contacts to obtain a larger and less biased sample. Answers were admitted from February to July 2021. On the first screen of the questionnaire, potential participants were informed that it was anonymous and that they could withdraw at any time during the process. Moreover, they were asked for their authorisation to use their data at the bottom of the screen. Therefore, the study complied with the ethical values required in any research that includes people: written informed consent, right to information, protection of personal data, confidentiality, non-discrimination and option to abandon the study at any time (McMillan and Schumacher, 2001).

Instrument

The Self-made Material Questionnaire. The Self-made Material Questionnaire (SMMQ) was designed by Méndez-Giménez and Fernández-Río (2011) to assess the perceptions of teacher education students about self-made materials. Subscale 1 asked participants to reflect on their beliefs and feelings about self-made materials. Subscale 2 asked participants to rate their use during a unit or program. The SMMQ’s $\alpha$ Cronbach’s factor was found to be high, 0.913, which indicated the questionnaire’s high internal consistency. Since then, it has been used on numerous occasions, obtaining more than acceptable and high levels of internal consistency with different populations and contexts (e.g. Fernández-Río and Méndez-Giménez, 2013; Méndez-Giménez and Fernández-Río, 2012, 2013; Méndez-Giménez et al., 2016a, 2016b; $\alpha = 0.923$, 0.871, 0.903 and 0.89, respectively).

An adapted version of the questionnaire developed by Méndez-Giménez and Fernández-Río (2011) was used to measure the perceptions and beliefs of the participating teachers about the use of self-made material in PE, in general, as well as during the pandemic (in its different educational scenarios). The questionnaire is made up of two scales with a total of 41 items. Demographic questions were included regarding the country, gender, age, years teaching PE, educational stage at present, type of school (state-funded, public and charter), training received on self-made material and previous experience with self-made material. The questionnaire was in Spanish and has been translated in this paper.
Teachers’ beliefs about the use of self-made material scale. The first scale consists of 21 items and collects teachers’ opinions on the use of the SMM before the pandemic as a teaching methodology (items 1–4), as a tool to promote interdisciplinarity (items 5–10), as a strategy for values education (items 11–16) and as an assessment tool (items 17–21).

Teachers’ perceptions of the impact of self-made material usage during the pandemic scale. Only teachers who used the SMM during the pandemic answered this second scale. It consists of 20 ad hoc items and measures three dimensions:

1. Teacher perceptions of the SMM effects on students’ educational and psychological outcomes (items 1–7: interest, motivation, benefits, content learning, motor skills, physical condition and meaningful knowledge).
2. Disadvantages of their implementation (items 8–13; e.g. students did not build them, students did not bring them, poor quality of materials, materials were easily damaged, they were dangerous and students were amotivated).
3. Teacher perceptions of the effects of the use of self-made material for personal benefit: (items 14–20: deliver new content, usefulness, profitability, level of satisfaction, expectations of professional use, help/support and commitment).

For both scales, the items were assessed using a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = indifferent, 4 = agree, 5 = strongly agree), to express the degree of agreement with each variable.

The reliability of the scales (a) Teachers’ beliefs about the use of self-made material scale and (b) Teachers’ perceptions of the impact of self-made material usage during the pandemic scale in the present study were Cronbach’s α = 0.91 and 0.94, respectively, which indicates a high internal consistency.

Statistical analysis
Data were entered and analysed using the IBM-SPSS© 24 computer program. Descriptive statistics were calculated, and the reliability of the scales was checked by means of Cronbach’s alpha. Acceptable values in all the scales were found (α > 0.70; Nunnally, 1978). Student’s T test was performed for comparisons by gender and one-way analysis of variance (ANOVA) was run for comparisons by age ranges. Three age ranges were established, using the criterion that each range covered 1/3 of the interval between the oldest and youngest of the participants (ranges 1 = 20–36; 2 = 37–53; 3 = 54–70 years). Following Gravetter and Wallnau (2014), it was determined that a variable followed a normal distribution when the absolute values of asymmetry and kurtosis were less than 2, which was true in all cases.

Results
Teachers’ beliefs about the use of self-made material scale
Table 1 shows the frequency and percentage of participants by country of origin.

Regarding the type of school, 880 teachers reported that they worked at state-funded schools (80.5%), 69 at charter schools (6.3%), 129 at public schools (11.8%) and 15 did not answer. Regarding PE teaching experience, the results were as follows: between 1 and 5 years: 263 (24.1%); between 6 and 10: 141 (12.9%); between 11 and 15: 204 (18.7%); between 16 and 20: 153 (14.0%); between 21 and 25: 158 (14.5%); between 26 and 30: 82 (7.5%) and over 30: 92
(8.4%). Regarding the educational stage where participants were teaching PE at the time (several boxes could be checked if it was the case), 227 (20.8%) taught in kindergarten; 694 (63.6%) in primary school; 457 (41.8%) in secondary education; 189 (17.3%) in baccalaureate; 63 (5.8%) in vocational training; 78 (7.1%) in university degree; and 26 (2.4%) in university postgraduate studies. Regarding training received in the use of self-made material for PE, 296 (27.1%) respondents reported that they had never received it; 291 (26.6%) were self-taught; 238 (21.8%) obtained it through training courses; and 268 (24.5%) acknowledged having received specific training in college.

Regarding the level of experience with self-made materials, 122 teachers (11.2%) reported no experience at all (they had never used it in class); 305 (27.9%) reported almost no experience (they had barely used it in 1–2 instances/teaching units); 407 (37.2%) reported some experience (3–5 instances/teaching units); 161 (14.7%) a lot of experience (6–10 instances/teaching units); 80 (7.3%) plenty of experience (more than 10 instances/teaching units); and 18 (1.6%) did not answer.

Table 2 shows the descriptive statistics of the subscale Teachers’ beliefs about the use of self-made material, both for the total sample and by gender.

All mean scores are close to 4 (out of 5 points) or higher. The highest scores are in item 13 (‘Favour students’ creativity and imagination’, $M = 4.43$), followed by item 12 (‘Allow to work on environmental education, recycling and waste materials’, $M = 4.40$) and item 11 (‘Allow to develop values such as respect for one’s and others’ materials’, $M = 4.29$). The three aspects refer to education on values. The lowest scores emerge in item 19 (‘Help assess students’ capacities’, $M = 3.72$) and item 20 (‘Allow for students’ self-assessment and co-assessment’, $M = 3.98$), both from the assessment category.

Comparisons by gender. Levene’s test to measure quality of variances indicated that the homoscedasticity assumption was met ($p > .05$). Significant differences were found in seven items. Women scored higher than men in all of them: item 2, $t(1, 1090) = -3.370$, $p = .001$; item 7, $t(1, 1090) = -2.811$, $p = .005$; item 8, $t(1, 1090) = -2.112$, $p = .035$; item 9, $t(1, 1090) = -2.630$,

Table 1. Participants: Frequency and percentage by country.

| Country     | Frequency | Percentage |
|-------------|-----------|------------|
| Spain       | 424       | 38.8       |
| Mexico      | 294       | 26.9       |
| Argentina   | 139       | 12.7       |
| Chile       | 84        | 7.7        |
| Peru        | 58        | 5.3        |
| Colombia    | 21        | 1.9        |
| Ecuador     | 15        | 1.4        |
| Guatemala   | 8         | 0.7        |
| Bolivia     | 7         | 0.6        |
| Portugal    | 7         | 0.6        |
| El Salvador | 6         | 0.5        |
| Brazil      | 5         | 0.5        |
| Venezuela   | 5         | 0.5        |
| Honduras    | 5         | 0.5        |
| Cuba        | 5         | 0.5        |
| Costa Rica  | 5         | 0.5        |
| Puerto Rico | 5         | 0.5        |
Comparisons by age ranges. A variable was generated for age ranges. One-way ANOVAs showed that there were no significant differences between groups in any of the comparisons ($p > .05$).

To the question: ‘Have you used self-made material in your PE classes during the pandemic?’ in total, 260 (23.79%) teachers negatively answered (and ended the questionnaire here), while 833 teachers answered affirmatively (76.21%), and they continued to fill in the second scale of the questionnaire.

Table 2. Teachers’ beliefs about the use of self-made material.

| Item                                                                 | Total sample | Men          | Women        |
|----------------------------------------------------------------------|--------------|--------------|--------------|
|                                                                      | $N = 1093$   | $N = 650$    | $N = 443$    |
|                                                                      | $M$          | $SD$         | $M$          | $SD$         | $M$          | $SD$         |
| 1. Mean a teaching methodology that demands greater teacher commitment | 3.99         | 1.22         | 3.97         | 1.23         | 4.02         | 1.20         |
| 2. Mean a teaching methodology that demands greater student commitment | 4.04         | 1.20         | 3.94         | 1.23         | 4.19**       | 1.13         |
| 3. Mean a teaching methodology that can nurse diversity better        | 3.98         | 1.23         | 3.95         | 1.24         | 4.03         | 1.21         |
| 4. Mean a teaching methodology that includes students with special needs | 3.91         | 1.24         | 3.88         | 1.24         | 3.95         | 1.24         |
| 5. Allow to work on goals shared by different subjects                | 4.13         | 1.16         | 4.09         | 1.17         | 4.18         | 1.14         |
| 6. Allow to work on the development of key competences                | 4.17         | 1.18         | 4.13         | 1.10         | 4.23         | 1.10         |
| 7. Facilitate a greater acquisition of knowledge from other subjects   | 3.96         | 1.14         | 3.88         | 1.17         | 4.07**       | 1.09         |
| 8. Favour curricular adaptations and modifications for students with special needs | 3.93         | 1.16         | 3.86         | 1.17         | 4.02*        | 1.15         |
| 9. Promote students’ extracurricular activities                        | 4.18         | 1.18         | 4.10         | 1.21         | 4.29**       | 1.13         |
| 10. Help assess different subjects’ content integration                | 3.94         | 1.16         | 3.87         | 1.17         | 4.04*        | 1.13         |
| 11. Allow to develop values such as respect for one’s and others’ materials | 4.29         | 1.19         | 4.26         | 1.20         | 4.32         | 1.19         |
| 12. Allow to work on environmental education, recycling and waste materials | 4.40         | 1.18         | 4.38         | 1.20         | 4.44         | 1.16         |
| 13. Favour students’ creativity and imagination                        | 4.43         | 1.17         | 4.40         | 1.17         | 4.48         | 1.16         |
| 14. Allow more coeducational activities than traditional resources     | 4.10         | 1.21         | 4.05         | 1.24         | 4.17         | 1.18         |
| 15. Allow to work in a more egalitarian and equitable way              | 4.05         | 1.23         | 3.97         | 1.26         | 4.16*        | 1.17         |
| 16. Help to develop education for responsible consumption              | 4.17         | 1.24         | 4.10         | 1.26         | 4.27*        | 1.19         |
| 17. Help assess students’ motor skills                                | 4.02         | 1.17         | 3.99         | 1.21         | 4.06         | 1.12         |
| 18. Help assess students’ attitude and commitment towards the subject  | 4.09         | 1.15         | 4.04         | 1.18         | 4.16         | 1.11         |
| 19. Help assess students’ capacities                                  | 3.72         | 1.18         | 3.68         | 1.19         | 3.79         | 1.15         |
| 20. Allow for students’ self-assessment and co-assessment              | 3.89         | 1.18         | 3.91         | 1.20         | 3.86         | 1.16         |
| 21. Hold more advantages than disadvantages for teaching              | 3.98         | 1.21         | 3.95         | 1.24         | 4.01         | 1.18         |

* $p < .05$; ** $p < .01$. 
**Teachers’ perceptions of the impact of self-made material usage during the pandemic scale**

Table 3 shows the descriptive statistics of the Teachers’ perceptions of the impact of self-made material usage during the pandemic scale, both for the total sample and by gender.

The highest score was obtained by items 18 (‘Have made me look forward to using them in the future’, $M = 4.28$), 19 (‘Have been of great help to the development of lessons’, $M = 4.22$), 15 (‘Have been useful to teach the PE subject’, $M = 4.22$) and 16 (‘Have been economically profitable’, $M = 4.21$). The lowest scores (below 2 points) refer to the disadvantages found: item 13 (‘The materials amotivated the students’, $M = 1.79$) and item 12 (‘The materials were found to be dangerous’, $M = 1.80$).

**Comparisons by gender.** Levene’s test to measure quality of variances indicated that the homoscedasticity assumption was met ($p > .05$). Student’s $T$ test showed that there were no significant differences between groups in any of the comparisons ($p > .05$).

**Comparisons by age ranges.** Levene’s test to measure quality of variances indicated that the homoscedasticity assumption was met ($p > .05$). Student’s $T$ test showed that there were no significant differences between groups in any of the comparisons ($p > .05$).

Table 3. Teachers’ perceptions of the impact of self-made material usage during the pandemic.

| The self-made materials used in PE lessons during the pandemic (items 1–7) | Total sample $N = 833$ | Men $N = 479$ | Women $N = 354$ |
|---|---|---|---|
| 1. Have increased students’ interest in the subject | 4.00 | 1.11 | 3.97 | 1.12 | 4.03 | 1.09 |
| 2. Have increased students’ motivation in the subject | 3.99 | 1.12 | 3.97 | 1.16 | 4.03 | 1.06 |
| 3. Have been very beneficial for students | 4.05 | 1.13 | 4.00 | 1.16 | 4.11 | 1.09 |
| 4. Have facilitated the learning of the content | 4.12 | 1.11 | 4.10 | 1.13 | 4.15 | 1.09 |
| 5. Have made students improve their motor skills | 4.13 | 1.14 | 4.11 | 1.15 | 4.16 | 1.13 |
| 6. Have allowed students to improve their physical condition | 3.86 | 1.14 | 3.82 | 1.16 | 3.92 | 1.10 |
| 7. Have allowed students to gain more meaningful knowledge | 4.10 | 1.14 | 4.05 | 1.17 | 4.17 | 1.09 |

The main disadvantages of the self-made material used during the pandemic (items 8–13)

| 8. Many students did not build them | 2.96 | 1.19 | 2.91 | 1.19 | 3.04 | 1.21 |
| 9. Many students did not bring them to school | 2.83 | 1.21 | 2.80 | 1.23 | 2.87 | 1.19 |
| 10. The materials were of poor quality | 2.57 | 1.10 | 2.56 | 1.08 | 2.59 | 1.12 |
| 11. Materials were frequently damaged | 2.82 | 1.14 | 2.79 | 1.12 | 2.86 | 1.17 |
| 12. The materials were found to be dangerous | 1.80 | 1.00 | 1.80 | 0.99 | 1.81 | 1.03 |
| 13. The materials amotivated the students | 1.79 | 1.02 | 1.75 | 0.99 | 1.85 | 1.06 |

The self-made materials used during the pandemic (items 14–20)

| 14. Have allowed to deliver new content | 4.01 | 1.14 | 3.96 | 1.17 | 4.07 | 1.09 |
| 15. Have been useful to teach the PE subject | 4.22 | 1.11 | 4.19 | 1.13 | 4.26 | 1.08 |
| 16. Have been economically profitable | 4.21 | 1.17 | 4.17 | 1.19 | 4.28 | 1.15 |
| 17. Have provided me with a satisfactory experience | 4.18 | 1.15 | 4.14 | 1.19 | 4.25 | 1.09 |
| 18. Have made me look forward to using them in the future | 4.28 | 1.15 | 4.24 | 1.17 | 4.34 | 1.12 |
| 19. Have been of great help to the development of lessons | 4.23 | 1.16 | 4.18 | 1.20 | 4.31 | 1.11 |
| 20. Have increased my commitment to the subject | 4.09 | 1.22 | 4.04 | 1.25 | 4.17 | 1.17 |
Discussion

The main objectives of this study were to analyse PE teachers’ beliefs about and perceptions of the use of self-made material in their lessons before and during the pandemic.

In relation to hypothesis 1 (teachers would positively value the use of self-made material as a teaching methodology, as a tool to promote interdisciplinarity, as a strategy to educate on values and as an assessment tool), the results fully confirmed it.

First, the participants highly rated the characteristics of the SMM collected in the first scale. They highlighted its potential to develop student creativity and imagination, to work on environmental education, awareness about waste and recycling, and respect for one’s own and others’ material. This pattern, which emphasises education on values, is consistent with the findings of previous studies with teacher education, sports science and Master of Education students, in both Spain and Portugal (Fernández-Río and Méndez-Giménez, 2013; Méndez-Giménez and Fernández-Río, 2010, 2012, 2013; Méndez-Giménez et al., 2016a). Baena-Morales et al. (2021a) also found that in-service PE teachers (n = 203) had high consciousness for the three dimensions of sustainable development (environmental, social and economic). Taken together, these findings support the notion that PE, its teachers and the SMM do have unique characteristics to contribute to the SDGs. Furthermore, other cross-curricular values such as equality, coeducation or education for consumption were also positively associated with the model.

Second, the respondents value the aspects related to interdisciplinarity and methodology. By having their own resources, teachers consider that a door opens to the development of extracurricular activities, key competences and interdisciplinary projects (results of items 6, 7 and 9). These findings are in line with data reported by Abellán and Hernández-Martínez (2021) and Méndez-Giménez et al. (2010, 2017). Results also confirmed that teachers consider these resources a way to address students’ diversity and to adapt the material to the needs of students with disabilities (Abellán, 2020; Méndez-Giménez and Fernández-Río, 2011). A recent study (Abellán and Hernández-Martínez, 2021) showed that pre-service teachers of PE improved their attitudes towards self-made material (as a teaching methodology and as a tool to promote interdisciplinarity) when they implemented a Service-Learning program that served a group of people with intellectual disabilities. Standard commercialised equipment is not as adaptable to students’ needs. It is always the same for everyone, no matter their ability level. On the other hand, self-made equipment can be constructed to fit each student’s needs. Features such as weight, length or shape can be manipulated to build the required piece of equipment. Therefore, they promote the inclusion of disabled students in PE contexts. Similarly, these types of materials also support diversity and gender differences, since they can also be adapted to fit individual needs. These two features endorse the idea that self-made equipment helps curricular individualisation in PE settings.

Third, the participants rated lower the potential of the SMM as a tool for student hetero-, self- and co-assessment. These lower scores have also been reported in previous studies (Méndez-Giménez and Fernández-Río, 2013; Méndez-Giménez et al., 2016a) and reveal teacher concern about how to approach assessment when the SMM is implemented. Future programs should improve the training of in-service teachers about assessment within the model.

Regarding hypothesis 2 (women teachers would more highly value some aspects of this methodology: interdisciplinarity, education in values and assessment), the results allow us to partially accept our hypothesis. First, female teachers rated four items related to self-made material as a means to promote interdisciplinarity (‘Facilitate a greater acquisition of knowledge from other
subjects’, ‘Favour curricular adaptations and modifications for students with special needs’, ‘Promote students’ extracurricular activities’ and ‘Help assess different subjects’ content integration’) more highly than male teachers. Second, women scored more highly on two items related to education on values (‘Allow to work in a more egalitarian and equitable way’ and ‘Help to develop education for responsible consumption’). Third, women scored more highly on an item related to methodology (‘They mean a teaching methodology that demands greater student commitment’). No differences related to assessment were found. Previous studies with PETE students found some differences between genders as well. Méndez-Giménez and Fernández-Río (2013) showed that women more highly valued both the requirement of greater commitment from the teacher and that self-made materials allow to work on common objectives with other subjects. Fernández-Río et al. (2014) reported that the sports science degree students in Portugal mentioned that they have fitted very well with the way of learning promoted by the use of self-made material. The authors pointed out that women seem to have greater sensitivity towards these types of educational resources. This may be because they consider themselves more skilled at crafting them (Fernández-Río et al., 2014). In this study, gender differences seemed more evident between in-service teachers regarding the beliefs about the SMM. The results show differences in favour of women in seven items. Women were more optimistic than men regarding the use of this pedagogical model to address disability, interdisciplinarity, equality and education for responsible consumption.

Regarding hypothesis 3 (participants would positively value the effects of the use of self-made material during the pandemic, both for the teacher themselves and for the students), the results allow accepting the hypothesis and emphasise that these resources were a valuable aid for the teacher to manage the restrictions imposed during the pandemic, in any of the educational settings. The four most highly valued items refer to benefits from the teaching perspective: high prospects for use in the future, great help for the classes, usefulness to deliver the subject and profitability in economic terms. At the same time, the level of teacher satisfaction with these resources was high since they allowed them to address the content of the subject. These results are consistent with data from previous research conducted with PETE students and in non-pandemic contexts (e.g. Méndez-Giménez and Fernández-Río, 2011, 2013). Furthermore, teachers also positively assessed the effects of the SMM on student outcomes during the pandemic. Teachers reported that these materials allowed students to improve their motor skills, facilitated learning and provided pupils with meaningful knowledge, increasing their interest and motivation. These results converge with previous literature. Several studies carried out in primary and secondary education reported students’ perceptions of improvement in their abilities and skills when using self-made material in PE programs (Fernández-Río et al., 2013; Méndez-Giménez et al., 2010, 2012, 2016b). This could be due to its adjustability to fit any size, weight or shape to the requirements of each player. Additionally, research shows positive outcomes at a motivational level such as high interest, enjoyment and enthusiasm in students (García-Romero, 2016; Méndez-Giménez et al., 2010, 2016b; Méndez-Giménez and Pallasá, 2018). Finally, the lowest scores refer to the disadvantages, such as the difficulties of the construction and transportation to school, and poor quality or durability. At the same time, the participants disagreed that the created materials were dangerous or amotivated the students. Overall, the instructions and guides offered by teachers to the students to build the materials, as well as the internet video tutorials used to follow the steps to construct could have allowed the resources created by students to be of adequate quality (Méndez-Giménez, 2018).

The results confirmed hypothesis 4 (no gender differences in teachers’ perceptions of the use of the self-made material during the pandemic). Positive teacher evaluations on the use of the SMM
during the pandemic were reported regardless of gender. Although differences in some beliefs about the use of self-made material before the pandemic (with the total sample) were found, teachers (both female and male) who used it during the pandemic claimed no differences regarding the impact of the model on students and teachers. Finally, hypothesis 5 was also confirmed (there were no significant differences according to age in any of the scales). Teachers’ beliefs and perceptions about the SMM, both before and during the pandemic, remained similar regardless of age.

From a theoretical point of view, self-made material usage has gained further support from both the three constructivist tenets (Perkins, 1999) and the constructionist framework (Papert, 1987). To become active learners, students should be involved in tasks that stimulate decision-making, critical thinking and problem-solving skills. The process of crafting self-made equipment allows the students to develop these skills, since they must decide where to find the materials needed, and debate how to best use them to craft their assigned piece of equipment. In this study, the teachers considered that the self-made materials ‘have been very beneficial for students’, ‘have facilitated the learning of the content’ and ‘have allowed students to gain more meaningful knowledge’. With enough materials in class, there can be an increase in student active learning time (Méndez-Giménez et al., 2010). Therefore, they have more opportunities to practice the skill and the games (both during lessons and extracurricular) and develop as active learners (Méndez-Giménez et al., 2016a, 2016b). In this study, the teachers considered that the self-made materials ‘have made students improve their motor skills’ and ‘have allowed students to improve their physical condition’. To grow as social learners, students must build knowledge through social interaction with their peers. While crafting materials and assessing their effectiveness, students interact with others (e.g. peers and relatives) inside and outside of the school setting, consequently becoming social learners. Both classmates and teachers have the opportunity to check what each one has done and value it since it is a group experience. This process builds more meaningful knowledge: an inner knowledge that emerges from an outer construction. Papert (1987) argues that students build their own knowledge structures parallel to the construction of artefacts. This may be due to the increased involvement, interest and intrinsic motivation of the builder. In this study, the teachers considered that the self-made materials ‘have increased students’ interest in the subject’ and ‘have increased students’ motivation in the subject’. Lastly, in order for the students to be creative learners, they need to be guided to discover knowledge by themselves as well as to create their own understanding of the matter. When students are asked to craft a piece of equipment, they must find a good functional design, they must negotiate rules and they must share information to develop a ‘useable’ end-product. In this study, the teachers considered that the self-made materials ‘favour students’ creativity and imagination’ and ‘have allowed students to gain more meaningful knowledge’.

Several features and virtues that in-service teachers attribute to the SMM connect with the SDGs and specific targets established in the 2030 agenda by the United Nations: 4.5. Reduction of gender disparities in education and equality of vulnerable people; 4.7. Promote global education for sustainable development; 5.5. Participation of women and equal opportunities; 12.1 Application of the framework on sustainable consumption and production; 12.2 Achieve efficient use of natural resources; 12.5. Prevention, reduction, recycling and reuse of waste; and 12.8. Ensure education for sustainable development (Chen, 2016; Chen and Breeding, 2022).

Lastly, the COVID-19 pandemic has highlighted the need for further professional development in order to prepare teachers for similar scenarios. In this sense, two measures are suggested: (a) specific training of both in-service teachers and PETE students on homemade resources that promote PE, sports and recreation; and (b) educational authorities and organisations should be urged to
develop digital platforms (in several languages) that guide teachers, students and parents with tutorials on how to efficiently build and use these self-made resources.

In conclusion, this international sample of PE teachers reported numerous benefits of the use of self-made material, both before and during the pandemic. In the COVID-19 era, self-made material is playing a relevant role, both as a meaningful resource and as a useful teaching methodology during the pandemic. Furthermore, they also focused on the contribution of self-made materials at different levels: cognitive (e.g. significant knowledge, new content, creativity), physical-motor (skills), affective (interest, usefulness, motivation and enthusiasm), and for the development of values (e.g. education for responsible consumption, environmental awareness, recycling, equal opportunities and taking care of the material).

This study is not without limitations. For example, the type of sampling used and the descriptive and cross-sectional nature of the study. The snowball research sampling should be improved by using stratified random sampling. Future research should study the effects of the model using: (a) experimental and longitudinal designs and (b) theoretical frameworks such as the theory of self-determination. Likewise, it would be interesting to complement this quantitative research with qualitative studies that would shed light on the difficulties encountered by teachers and strategies to solve them.

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