Technology enhanced learning in physical education? A critical review of the literature

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Technology enhanced learning in physical education? A critical review of the literature


Abstract

**Purpose:** In this review, the three components of pedagogy (i.e., teaching, learning, curriculum) were used to critically investigate what is argued to be 'enhanced' by digital technology.

**Method:** Using a critical methodology, an answer was sought to the question of 'what aspect(s) of pedagogy is claimed to be enhanced by the use of digital technology in PE?' The final set of papers are presented in terms of the claimed technological enhancement in teaching, learning, curriculum.

**Findings:** Interestingly, technology enhancements are presented most prevalently in terms of ‘enhancing student learning’ in areas such as health or motivational variables. Technology was mainly used as a substitute for the teacher and not transformative teaching and learning.

**Discussion/Conclusion:** A critical analysis regarding what is done in the 'name of PE'. This paper concludes by presenting suggestions on how to move the field forward and to debate the roles of digital technology in PE.

**Keywords:** educational technology, digital technology, PE, pedagogy, TEL.
**Introduction**

This article was written at a time when online education and using different technologies to access educational materials from our homes came to the fore due to the COVID-19 pandemic. From this context, many are aware that technology offers education a number of opportunities, in terms of enhancing existing provisions, but also challenges such as creating inequalities (Howley 2021). Now, more than ever, there is a need to develop critical education technology agendas that address issues such as pedagogy which make use of recent theoretical and methodological approaches (Selwyn et al., 2020). Expanding further on this point, Selwyn et al. (2020) argue that it is important that academic work commits to engaging in sustained and collective conversations about how we might successfully drive critical educational technology scholarship throughout the 2020s. Reflecting on recent scholarship in relation to technology (e.g. iPad apps, smartwatches or videos) and its impact on areas of pedagogy, it is argued that the effect of using technologies such as mobile devices in education is better than when using desktop computers (Sung et al. 2016), that effective use of technology (e.g. through feedback and gamification) can mediate supportive pedagogies (Yates et al. 2021) and how technology can help enhanced authentic assessment (Jopp, 2020). The effectiveness of digital-based interventions has also been reported worldwide over different age groups such as pre-school, elementary, secondary or third level education, and in different subject areas such as mathematics (Benavides-Varela et al., 2020); music (Crawford, 2017); language (Parmaxi, 2020), or geography (Adedokun-Shittu et al., 2020).

Yet, in the field of PE, only recently has there been an engagement and critical discussion regarding the interrelationship between technology and pedagogy. Indeed, Casey et al. (2017) argue that a considerable gap exists in relation to the connection between digital technology and
pedagogy. Subsequently, it would seem pertinent to explore these three areas of curriculum, learning, and teaching practice and how they relate to technological enhancement. That being said, ‘educational technologies have been known to positively impact teaching and learning in physical education’ (Phelps et al. 2021). For example, there are previous studies that explore technologies such as Massive Open Online Courses (MOOCs) which have been demonstrated to positively impact professional development (Griffiths et al. 2021) or how digital game design can help to support students’ learning experiences (Pill et al. 2021), but also, its use for digital assessment (Penney et al., 2012).

Whilst there is not a consensus on the meaning of pedagogy, as it means “different things to different people” (Tinning, 1992, p. 24), Kirk et al. (2006, p. xi) defines pedagogy in terms of the three elements of “learning, teaching and curriculum”. Considering these three elements in turn, within learning, children and young people are foregrounded and the focus is on the multitude of ways that they can be supported to learn, thrive and engage in effective knowledge exchange (Armour, 2011; Casey, Goodyear, & Armour, 2017). Our views of learning align with Quennerstedt et al. (2011, p.162) in viewing learning as “meaning making resulting in a more specific repertoire or act”. The teaching or teacher(s) dimension of pedagogy considers teachers who are continuously critically reflecting on their personal and professional abilities to support young learners (Armour, 2011; Casey et al., 2017). Our views of teaching align with Biesta (2017), where teaching is understood as the responsibility of bringing something to the educational situation that was not already there. Teaching understood as a process where teachers have something to give to their students (Biesta, 2012; Quennerstedt, 2019). The final element of curriculum is aligned with the view that it is as an educational experience; as a plan, that must be lived, experienced, and embodied young people and teachers (Pinar, 2012).
In seeking to theoretically frame research in this area, one can often see the use of the TPACK framework which seeks to explore both the technological, pedagogical and knowledge aspects involved with technology integration. Examples include Krause and Lynch (2018) and Meroño et al. (2021), who argued that preservice teachers and teachers have varying experiences with instruction in relation to TPACK or Gawrisch et al. (2020) who recommend that teachers build their knowledge and learn to value technology in physical education. Whilst the use of this approach has been helpful in negotiating the aspects of technology and pedagogy, the views in this paper align with Voogt et al. (2013) in arguing that the limited knowledge pertaining to use and develop TPACK can result in a deficit view of teachers that are characterised as either having or not having the relevant knowledge bases. For example, by critically exploring technology enhanced learning (TEL) in relation to these areas of pedagogy, this paper can address a notable gap in the literature and begin to systematically investigate areas that are of pedagogical importance (Casey et al., 2017). Research that supports our understanding of technology-enhanced learning in PE is still developing (c.f. Casey et al., 2017; Krause, O’Neil, & Jones, 2019; Wyant & Baek, 2019). Whilst recent research suggests that the emerging focus on instructional technology in society and education has not been effective in providing the basis for widespread adoption in PE, its role in PE remains in question (Wyant & Baek, 2019).

As argued by Passey (2019) TEL covers much more than a focus on learning and is also concerned with areas such as education, the management of education. Yet, in addressing this gap, we are conscious of the need to problematise TEL more generally in relation to questioning what is ‘enhanced’ and how do we know it is enhanced? (Kirkwood & Price, 2014). Others go as far as the need to problematize the very ontological underpinnings of TEL (Bayne, 2015). Whilst it is beyond the scope of this paper to attend to the nature of these debates, there remains the
need to critically review what aspect of pedagogy is claimed to be enhanced using digital technology. Furthermore, who is the subject of the claim of enhancement such as the teacher, learner, or educational bodies. Attending to such areas addresses a notable gap in the field of PE and sport pedagogy and will serve as a recognized source of information to inform future research and decision making in relation to the use of digital technology in PE. Therefore, the purpose of this paper is to critically review TEL in the PE literature with specific relationship to the notion of pedagogy.

Methodology

Situating the review theoretically

This review utilises a ‘critical methodology’ (Cushion & Townsend, 2019) that draws upon some principles of systematic review (Alexander, 2020). This approach was chosen as it has generated interest in the field of education, including the field of educational technology (Bedenlier et al., 2020) and to draw upon similar principles utilised in the literature such as Kirkwood & Price (2014). It is particularly suited to this research area in PE as the term ‘enhanced’ is widely used in the literature, but frequently considered un-critically (Kirkwood & Price, 2014). This argument is further positioned in relation to conceptions of teaching, learning, and curriculum in which the categories and the relationship between them are also left unquestioned (Casey et al., 2017; Kirkwood & Price, 2014). The research question that guided this critical review is: What aspect(s) of pedagogy (teaching, learning or curriculum) is claimed to be enhanced by the use of digital technology in PE? This guiding question allows us to explore the different elements of pedagogy that have been outlined in the introduction.

Search strategy and parameters
Literature was selected from searching the databases of Web of Science, Scopus, and Dialnet, through a title and abstract search procedure. Following Alexander (2020) directions these database searches were limited to peer-reviewed publications that were published between 2015 and 2020. The main search keywords were a combination of both a technology based key word and an identifier from PE in both the abstract and title. The search terms were used in both English and Spanish. For example, some of the search terms we used were a combination of ‘technology-enhanced learning’ AND ‘physical education’, and ‘physical education’ AND ‘digital technology’1. A manual search of the list of references of selected articles was also performed, not resulting in the inclusion of more papers to the ones yielded through the database search.

**Inclusion and exclusion criteria**

Given the authors backgrounds, this critical review considered empirical English and Spanish-language research undertaken between 2015 and 2020 that was published in print or digital formats, in peer-reviewed articles relevant to the research question. The rationale for this timeframe is to encompass five years of rapid technological development and the relatively nuanced nature of the work on technology in the PE field, and the growing number of technology-based interventions. Encompassing published papers in both English and Spanish ensures that a greater balance of international perspectives and covers a body of literature.

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1 The full list of search terms and the search strategy included:
(1) “physical education” OR “PE”
(2) “educación física” OR “EF”
(3) 1 AND 2
(4) “technology” OR “digital technology” OR “technology-enhanced learning” OR “ICT”
(5) “tecnología” OR “tecnología digital”
(6) 4 AND 5
(7) 3 AND 6

The last database search was completed on July 21st 2021
covered by those reviews that have only explored English literature (Alexander, 2020). To further focus our review, several exclusion criteria were used: those papers which could not be freely accessed through either the databases or the university library, peer-reviewed papers not published between 2015-2020, peer reviewed papers that were not published in English or Spanish, peer reviewed papers that were not focused on the PE context, those that were not focused on school/college-based PE (e.g., physical education teacher education or higher education), those papers that were review pieces or theoretical based, those that did not include a technology-based intervention, and those where PE is delivered completely through online courses. Only papers where PE takes place on a regular face-to-face or blended approach were included. A total of 1909 papers were identified through databases (n=755, after duplicates).

From those, 534 were excluded after the initial screening (first stage) due to not meeting any of the inclusion criteria. 221 papers were examined in the full text analysis before 33 papers were finally included in the review.

**Analysis**

Following Kirkwood and Price’s (2014) and Cushion and Townsend’s (2019) approaches, selected papers were analyzed deductively. This approach was chosen as it allowed the capturing of the often iterate and nonlinear nature of reviews and to explore alternative paths to the findings (Alexander, 2020). A two-stage approach to this critical review of the literature was chosen to align with reviews such as Cushion and Townsend (2019) and to provide a semi-structured approach. The first stage involved mining the databases using our inclusion/exclusion criteria. Prior to individual coding, we completed a sub-sample of papers together to establish consistency between our approaches. Then, the authors individually reviewed and coded the title and abstracts, using Rayyan website tool for systematic reviews. The coding was then compared
between the authors and any points of clarity or conflicts were discussed and agreed. The second
‘quality screening phase’ involved a creation of a descriptive matrix of the literature to provide a
map of the TEL field (Cushion et al., 2010; Cushion & Townsend, 2019). The initial map
involved reading and filtering the full articles in terms of the article focus (and coverage) of
technology (e.g., the platform, device, software of study) and the three areas of teaching (e.g., a
detailed description of the intervention), learning (e.g., evidence of learning), or curriculum (e.g.,
findings related back to extract of curriculum documentation or analysis of how curriculum
extracts have been applied in practice using technology). In order to capture the outcomes of this
screening phase, a similar technique to Araujo, Mesquita, and Hastie (2014) was employed
whereby a formal quality score for each study was completed on a two point scale by assessing
the paper value of 0 (none present or inadequately described) or 1 (present and explicitly
described) in relation to each of the following areas described by Cushion et al. (2010) and
Cushion and Townsend (2019): (a) the appropriateness of the paper focus for answering the
review question (i.e. topic relevance), (b) the trustworthiness of the results assessed by the
quality of the study (i.e. methodological and theoretical rigour), (c) appropriateness of the study
for addressing the research question (i.e. relevance). The scores (which can be viewed in table 1)
were initially scored individually by each author (87.8% of agreement was reached which is 29
of 33 papers) before coming together to review the scores to reach consensus. Scores with a total
of 1 or less were excluded and those with an average score of 2 or more were included.

**Findings**

In table 1, we present the details of the final set of papers selected in the review process and
present them in terms of the research purpose, participants and context, study design, data
gathering, the description of the TEL intervention, the key findings, and the quality score
(Araujo et al., 2014). The findings in relation to the analysis of technology in relation to enhancements in teaching, learning and curriculum, and the main themes identified are presented in more detail below.

We thematically present the key findings presented in Table 1 through our discussion of technology enhancements in teaching, learning and curriculum.

*Technological enhancement in teaching: Using technology as a substitute of teachers but not as transforming teaching and learning practices*

Technology was largely seen as a support and a substitute in relation to enhancing existing teaching practices in PE. Technology was closely reported in line with what students had learnt because of the use of technology in teaching. The technologies that were claimed to enhance teaching varied from videos to exergames, apps, and tablets. They were used mainly in elementary education, but also with secondary and post-secondary samples. The most prevalent of these were apps followed by exergames and videos. Aspects of teaching that were claimed to be enhanced by technology included areas such as video-feedback and performance (Kretschmann, 2017; Palao et al., 2015), the ability to create new cultures for students (Andre & Hastie, 2018), and the direction of learning (Maivorsdotter & Quennerstedt, 2019). Some of these technological enhancements were linked to the ways that teachers could harness the use of technology towards assessment purposes. Studies that had a key teaching component to them tended to explore how the technology was implemented into the PE lesson or course in terms of the methodology of the study but then tended to focus more on the outcomes for students rather than the teachers themselves. For example, Lee and Gao (2020) reported on the variables in
terms of students’ physical activity, Lindburg et al. (2016) discussed student engagement alongside variations in heart rate and Segura-Robles et al. (2020) focused on student satisfaction and motivation. It is interesting therefore, that when technology is viewed towards enhancements in teaching, we are more likely to see a focus on bringing about a change in terms of students’ learning that was not already there, rather than say a change in pedagogical approach, instructional strategies, philosophies or critical thinking.

Technological enhancement in learning: Using technology to improve motor skills, health and motivation

Several different types of technology were beneficial for enhancing student learning (e.g. videos, exergames, apps, wearables, activity monitors or websites). Whilst technology was explored in relation to learning in a variety of ways, some of the most prevalent outcomes was to enhance students’ health/physical aspects of learning or on motivational related outcomes. For example, McGann et al. (2020) reported on how students made significant improvements in locomotor skills when using exergames, whereas Potdevin et al. (2018) and Palao et al. (2015) found that students made significant progress in their motor skill or athletics development and self-assessment ability when using video-feedback. Enhancements in learning were largely viewed from the perspective of learning in the physical domain or enhancing areas such as motor competence (Kretschmann, 2017). In relation to health-related aspects, technology in the form of exergames was reported to enhance students' self-esteem or mood (Andrade et al., 2020), knowledge of step count and calorie burning targets provided by a wearable fitness device encouraged young people to do more physical activity (Goodyear, Kerner, & Quennerstedt, 2017), or knowledge of energy balance and healthy diets (Chen et al., 2016).
Using technology to enhance motivational variables was also a key focus. There was evidence of aspects such as video-feedback that claimed to increase students’ motivation (Roure et al., 2019), accelerometers that were a motivating factor for some students to increase their physical activity (Marttinen et al., 2019) and increases in intrinsic motivation through the use of gamification and Flipped Learning (Østerlie & Kjelaas, 2020; Østerlie & Mehus, 2020; Segura Robles et al., 2020). Video guided technologies resulted also very positive to significantly improved the academic self-concept of adolescents with hearing impairment. As such, the use of technology to enhance student's motivation for either the subject more broadly or more specifically taking part in the physical learning tasks was a key pedagogical outcome when technology was implemented, particularly with elementary students, but also with secondary and post-secondary ones.

**Technological enhancement in curriculum: Using technology to facilitate the enactment of new curriculum**

The use of technology to enhance either the application, development or understanding of the curriculum would not seem to be a pertinent area of focus in the PE literature studies included in this review. Only Calderón and Tannehill (2020) presented a proposal where, a sample of PE teachers, used an ad hoc designed mobile app, to facilitate the enactment of a new curriculum framework. They reported that the engagement in a learning community of inquiry was paramount to these teachers’ development of effective practices when enacting a new models-based curriculum enhanced using one mobile app (Calderón & Tannehill, 2020). It seemed that whilst the papers may be implicitly reflecting on how the technology enhancements might impact on curriculum, the main focuses were on the students’ learning aspect of pedagogy. In addition, when looking at the curriculum contexts studies were mainly emanating out of
Europe followed by Asia, the USA and the UK. Elementary or primary PE was the most studied curriculum in terms of schooling.

Discussion

This paper sought to critically explore what areas of pedagogy are claimed to be enhanced by digital technology in PE. It presented how technology was largely seen to enhance students’ learning in relation to both health and motivational variables. Nonetheless the areas presented remain aligned with Casey et al. (2016; 2017). It highlighted the lack of new forms teaching or indeed a limited presentation of the context of the curriculum. Indeed, in looking at Puenteudra’s (2013) Substitution Augmentation Modification Redefinition (SAMR) model, most of the papers seemed to replicate existing practices, such as, using tablets as whiteboards or some apps to creates time intervals and signals (Lee & Gao, 2020). Technology was mainly used as substitute for the teacher (c.f. Papastergiou et al., (2020)) but not as transforming teaching and learning practices by allowing for significant task redesign or the creation of new tasks previously inconceivable without the use of technology. It is important to note however, that these studies used tablets and apps as instructional support and are not necessarily associated with poor teaching. The teacher, in these cases, could complement the app inputs, and spend more time in other teaching aspects such as giving feedback, suggesting task adaptations, and encouraging reflection. They could even create teachable moments based on certain situations and adapt their teaching given some of the apps used are not pedagogically framed and/or designed based on the individual students needs or interests (Selwyn et al., 2020).

The ‘enhanced’ forms of student learning in relation to health and motivational variables were a key aspect of the findings. That being said, it raised critically awareness that enhancements in students’ learning was seen from a rather narrow lens of what might be termed
‘learning’ in terms of health, physical, and motivational aspects. Indeed, as Quennerstedt (2019) discusses, a focus on activity levels and heart rate puts questions of education into the background. There was a real shortage of papers that explored students or teachers’ emotional or social learning. In addition, there was little discussion about the pedagogical use of technology to promote areas such as social justice, critical or democratic thinking or lifelong enjoyment of movement. Interestingly, this is a common pattern in technology-based research in other subjects such as mathematics (Benavides-Varela et al., 2020); music (Crawford, 2017); language (Parmaxi, 2020), or geography (Adedokun-Shittu et al., 2020), and indeed, it will be an interesting aspect to explore further. Furthermore, given the large focus on studies from a European context, one has to consider these ‘enhancements’ as having pockets of impact rather than being experiences as necessarily equal and global.

Taking this critical perspective further, one could argue that it seems that what the field of PE finds meaningful for students’ learning with technology is that it develops learning of a physical component. There was very little evidence of technology enhancing students' experience of technology as supporting fun, social interaction, challenge, or delight, considering the notion (and aligned research design) of learning as meaning (Quennerstedt et al., 2011). Arguably, Lee and Gao (2020) and Steinberg et al. (2019), would be two examples of technology enhancing student’s enjoyment and cooperation respectively, despite the TEL intervention was not intentionally designed with that purpose. With this in mind, one might question what meaning students’ take from this focus on technology to enhance motor competence and whether the use of technology to support or enhance students’ learning.

In relation to technology enhanced learning and teaching in PE, there was evidence of small, but nonetheless enhancements of areas such as the creation of new cultures for students
and (video) feedback. It is encouraging, however, to see the findings of papers like Maivorsdotter and Quennerstedt (2019) that sought to demonstrate that the teachers’ presence in the teaching and learning process with technology is important to ensure that traditional norms and values are challenged. This is because the digital tools themselves are unlikely to spur any radical changes in teaching merely by their presence. Furthermore, it is encouraging to see the extent to which certain refined exergames could enhance the user’s play experience (McGann et al., 2020), or the way the pedagogical use of certain apps can enrich a debate of ideas to enhance students’ shared understanding of tactical concepts (Koekoeck et al., 2019). Other examples include the way certain apps (such as #digitanz) can stimulate movement ideas, promote students’ agency and cooperation, but also create fears and obstacles related to data protection and privacy (Steinberg et al., 2019). All of these are illustrative examples of using technology for transformative teaching where the use of technology allowed for significant task redesign (Puentedura, 2013), but also add a level of pedagogical complexity where the role of the teacher is critical to promote good teaching. In other words, teaching was understood as a process where teachers bring something new and are key elements of the educational encounter (Biesta, 2012). That being said, the exploration of technology enhanced ‘teaching and learning’ (including assessment) in PE still has a long route towards enhancement. A point that was recently argued by Martinnen et al. (2020) claiming that close attention must be paid to the ways in which teachers’ perceptions could be augmenting or limiting the educational value of digital technologies in PE, and also, to realistically evaluate the strengths and constraints that technology-integrated PE lessons may pose in a traditional environment (Zhu & Dragon, 2016). It is hoped that technology does continue to enhance teachers teaching but, perhaps its progress
is underpinned by the need for technology to be seen to enhance the PE curriculum before this
change can be more widespread.

It is perhaps surprising to see such a gap in studies exploring technologies enhancement
of curriculum in PE. As Araujo et al. (2020) argue, educators and policy makers in the field of
PE are still adjusting local curricula to reflect the different technological changes and there
remains a lack of knowledge in how these digital developments have been undertaken in
different contexts. It would subsequently seem that how digital technologies are incorporated
into, interpreted through, and help inform the field’s understanding of PE curricula is still an
important aspect for future research. In thinking about future research in terms of exploring TEL
and indeed in PE, experimenting with, developing and reflecting on the use of technology-
enhanced pedagogy or what Passey (2019) recently termed technology-enhanced education
would allow for researchers and educators to seek to broaden out the investigation of technology
and the often overlapping areas of teaching, learning, and curriculum that underpin its use. We
are conscious and acknowledge certain limitations of this review. These include our
interpretation and judgement of the quality criteria used to review the studies, the incorporation
of studies in languages other than English or Spanish, database/full text access, or books and
conference papers. Furthermore, the exclusion of papers focusing on completely online PE is a
limitation. That being said, we aware of recent literature from Goodyear et al. (2021) that
somewhat addresses this gap in knowledge. Despite these, we embrace the idea of, and related
research about online-only PE. We believe that there is still a large research arena to explore the
realities of digital technology for teaching and learning in regular (and blended) PE. Future
research that explores a greater diversity of curriculum contexts and technologies would also
allow for a broader perspective on how the use of these technologies can be adapted. By seeking
to deploy pedagogical approaches that attempt to incorporate technology within their core design is key. Another area which could be worrying and promising at the same time would be the use of virtual worlds as arenas for embodied experiential learning to happen (Loke & Golding, 2016). Currently, many studies advocate for the use of teaching and learning approaches based on virtual worlds as powerful experiences that benefit students’ learning and disciplinary understanding (Pellas & Mystakidis, 2020). Exploring further the pedagogical approaches being used in completely online PE and their implications for student learning might be a worthwhile research focus as well (Kooiman, et al., 2016). Perhaps in broadening the use and exploration of digital technologies there can be movement towards addressing Quennerstedt’s (2019) ambition to develop a pedagogy of meaning which seeks to focus on meaningful experiences and the process of making new and holistic meaning out of experience, both in physical or virtual worlds.

**Conclusion**

In critically reviewing technology and its claims of enhancement with teaching, learning, and curriculum in PE, the question remains, what should be enhanced? In relation to what areas and with what focus? Literature (c.f. Passey, 2019) suggests that TEL encompasses more than just learning. Yet, from the findings within this review it seems that students’ ‘learning’ in relation to physical and motivational domains remains the focus in the context of PE. It would seem that this focus is reflective of the current status of technology use in the field and rather the findings of this review act as a platform for consideration of what has been achieved and what could be achieved in the future.

As a backdrop to this review, the context of the COVID-19 pandemic is likely to have spurred the field even further to reflect upon what the current state and use of technology within
pedagogy has been and where it could be when the schooling environment is augmented. Indeed, the boundaries of the gymnasium or sports field can be expanded with digital technology whilst exacerbating digital inequalities. A better understanding and picture of the small ways in which different types of technology can be used to enhance areas of teaching and learning is being developed. An area that very little was reported on a decade ago. Yet now, more than ever, adopting Casey et al.’s (2017) advice to be braver and bolder in critical thought regarding what outcomes are being sought to enhance through the use of technology and planning aligned teaching and learning experiences accordingly. If our predominant use of technology in the field is towards enhancing students’ physical and motivational aspects of learning, then there is a need to be conscious of the sort of educational process or future students are being guided towards.

Statement on conflict of interest

No potential conflicts of interest were noted by the authors.


Griffiths, M.A., Goodyear, V. A., & Armour, K. M. (2021). Massive open online courses (MOOCs) for professional development: meeting the needs and expectations of physical


