

A student-centred digital technology approach: The relationship between intrinsic motivation, learning climate and academic achievement of physical education pre-service teachers

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Abstract

There is a lack of research on the use of digital technology in physical education teacher education (PETE) and its relationship with the learning and engagement of pre-service teachers. Furthermore, research reports low engagement of pre-service teachers in digital approaches that do not promote active learning and are mostly teacher-centred. This paper aims to: (a) explore the relationship between a student-centred digital technology approach and the pre-service teachers' intrinsic motivation, learning climate and academic achievement; and (b) test the relationship between learning climate and intrinsic motivation as possible predictors of academic achievement. The student-centred digital technology approach was designed following an adaptation of the five-phase pedagogical guidelines for teaching with emerging technologies. Two intact classes ($n = 110$ students) and one teacher educator were involved in the study. Following a mixed-method approach, quantitative data was collected on pre-service teachers' intrinsic motivation, learning climate and academic achievement. Qualitative data explored pre-service teachers' tweets and learning blogs. Choice and novelty were two central tenets that conditioned high levels of intrinsic

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motivation and academic achievement. The study provides support for the use of active learning environments where pre-service teachers are involved in creative content production using digital technology in PETE programmes. Given the growing role of digital technology for learning in educational policies and new physical education curricula, we advocate for the publication of more research-based experiences on the integration of digital technology in PETE programmes. The transferability of such teaching and learning experiences to pre-service teachers' and physical education teachers' practice would be especially worthwhile.

Keywords

Teacher education, student-centred approaches, active learning, intrinsic motivation, social media, digital technology

Introduction

While digital technology is a central element of undergraduate education, it is not considered as 'transforming' the nature of university teaching and learning (Henderson et al., 2015). Indeed, it is seen to diminish undergraduate students' scholarship and provoke some digital disadvantages (e.g. digital technology as a distraction or disruption to learning) (Selwyn, 2016). Regardless, there are high expectations for digital technology to optimize student learning in schools and this is frequently reflected in educational policies and new curricula (Tondeur et al., 2007). Thus, teacher education programmes are challenged to digitally educate the new generation of future teachers. Numerous studies on digital technology for teaching and learning in higher education (Balakrishnan, 2014; Lackovic et al., 2017; Ng'ambi, 2013; So, 2016) advocate that, to have a transformative effect on students' motivation and achievement (Lutz and Culver, 2010), it is crucial to have a clear idea of the educational outcome. Aligned with this is the importance of considering a pedagogy of technology (Casey et al., 2016) that is grounded in authentic student-centred learning contexts (Calderón et al., 2017).

There is a lack of research in physical education teacher education (PETE) on the relationship between the use of digital technology and the pre-service teachers' (PSTs) engagement and subsequent learning. Furthermore, previous research reports a low level of PST engagement in digital approaches that did not promote active learning and tended to be teacher-centred (Calderón et al., 2017). Thus, this paper sheds new light on the relationship of a student-centred digital technology approach on PSTs' intrinsic motivation, learning climate and academic achievement. In addition, we explored the relations among learning climate and intrinsic motivation as possible predictors of PSTs' academic achievement. The following research questions were posed:

- (1) What is the relationship between the student-centred digital technology approach and the PSTs' intrinsic motivation?
- (2) What is the relationship between the student-centred digital technology approach and the PSTs' learning climate?
- (3) What is the relationship between the student-centred digital technology approach and the PSTs' academic achievement?
- (4) What is the relationship between the learning climate and intrinsic motivation as possible predictors of PSTs' academic achievement?

Digital technology for teaching and learning in (physical education) teacher education

While digital technology is generating considerable interest in terms of research and practice in physical education (Casey et al., 2017; Gard, 2014; Gibbs et al., 2016; Lupton, 2015; O'Loughlin et al., 2013; Sargent and Casey, 2019; Wyant and Baek, 2018), it is receiving little attention in (physical education) teacher education programmes (Chien et al., 2012). Most of the studies in teacher education explored the use of digital technology (video or multimedia) to enhance subject matter and to support classroom teaching (Tearle and Golder, 2008; Tondeur et al., 2012). For example, in the research by Admiraal et al. (2017), teacher educators used knowledge video clips, skills video clips and instruction video clips. Recently, there has been interest in PSTs (and undergraduate students in general) as producers of content, considered as a more involved approach to teaching and active learning (Snowball and McKenna, 2017; Song et al., 2017; Watling, 2012). Song et al. (2017) highlighted for example the utility of integrating popular social networking sites (such as Pinterest) as part of classroom assignments to provide a space in which students can actively explore, design and apply module-related ideas and thus extend their collaboration and informal learning. The results reported by Snowball and McKenna (2017) imply that the majority of first year undergraduate students felt that the experience of creating podcasts and infographics was beneficial to their learning. Linking theory to practice and demonstrating the relevance of ideas outside the lecture room were some of the reasons attributed to this learning (Snowball and McKenna, 2017). The same logic underlies the use of blogging (Deng and Yuen, 2011), instant messaging (So, 2016; Timmis, 2012) or mobile applications (Jeno et al., 2017). The use of these three digital opportunities increased students' motivation and socially oriented individual expressions (as well as reflective thoughts) that fit in a niche between formal assignments and casual communications (Deng and Yuen, 2011). While student-generated content is recognized as a unique learning activity influencing specific cognitive and high-level thinking processes (Blaschke, 2016), it is a topic that has not been thoroughly researched in the PETE context.

In the PETE context, Barker et al. (2017) and Hortigüela-Alcalá et al. (2019) illustrated how digital technologies and social networks were experienced by PSTs. Barker et al. (2017) proposed group work to investigate digital technology and develop a 'how to' guide for physical education teachers. After completing the guide, the PSTs were asked to prepare a walk-through lesson for their peers. As a result, the participants emphasized the advantages to using digital technologies for their learning. However, they highlighted that digital technology did not reduce the need for the PSTs to know the content and the technology well for successful integration. Recently, Hortigüela-Alcalá et al. (2019) reported how the pedagogical use of Twitter and Instagram increased PSTs' motivation and involvement towards the subject and their learning. In a similar vein, other research has accentuated that digital technology learning activities need to be designed carefully, and aligned with module learning outcomes, instructional strategies, technology affordances and PSTs' personal usage (Calderón et al., 2017). The PSTs also emphasized that the incorporation of social media and digital technology into educational processes must be based on sound pedagogical principles, with the construction of a relevant student-centred and active learning environment being pivotal to successful learning.

Rich environments for active learning in higher education

Active learning continues to generate considerable interest due to the transition to 21st century higher education and the 'new pedagogies' (Misseyanni et al., 2018). For this research we, as

others previously, define active learning as a term used by educators to describe a more learner-centred approach to teaching that involves students doing things and reflecting on what they are doing (Bonwell and Eison, 1991; Misseyanni et al., 2018). As Misseyanni et al. (2018) noted, active learning practices may range from simple methods (e.g. interactive lectures and class discussions) to case studies examining peer teaching and/or project-based learning. Rich environments for active learning: (a) support studies in meaningful and information-rich contexts; (b) encourage the growth of student initiative and decision-making; (c) promote an atmosphere of learning that utilizes collaborative learning through a student-centred approach and (d) use assessment for learning to measure student progress through authentic tasks (Grabinger and Dunlap, 1995). Active learning is underpinned by constructivist learning theory that conceptualizes learning as a process in which students learn best when they construct their knowledge in an active way, and when the learning is authentic and connected to real life (Vygotsky, 1978). The digital media of today's world offers new ways of expanding constructivism and synchronizing it with higher education and students' demands (Siemens, 2005).

Connectivism, as an instructional theory (Duke et al., 2013), provides several indicators that could develop previous learning theories, such as constructivism, and adapt them to teaching and learning in a networked world (Ito et al., 2013). The five-phase pedagogical guidelines for teaching with emerging technologies (problem statement, artefact design, presentation, reflection and assessment) are one such example (Ng'ambi, 2013). Connectivism offers specific technological opportunities for the learner to be actively involved in the presentation of a body of knowledge that has been created by collaboration and is meant to be shared (Duke et al., 2013). Brown et al. (2016) reported that undergraduate students who were engaged in online creative content production, supported by a connected learning environment, showed high self-motivation in achieving the module learning outcomes.

Aligned with the tenets of self-determination theory (SDT) (Ryan and Deci, 2017), rich environments for active learning are those environments that provide choice, give opportunities for initiative and promote task involvement. Ryan and Deci (2017) also postulated that the most autonomous forms of motivation, including intrinsic motivation, would lead to adaptive behaviour, cognitive and affective outcomes. Research also suggests that within the undergraduate student population in general, when integrating active learning and student-centred strategies in the teaching approaches, there is a consistent positive relationship between intrinsic motivation (Trevino and DeFreitas, 2014), self-efficacy (Sun et al., 2018) and academic achievement (Barton et al., 2018; Jeno et al., 2017).

Based on the literature review and prompted by the lack of research on the use of digital technology and its relationship with PSTs' perceptions of and engagement in PETE programmes, this study contributes to a deeper understanding of pedagogies of digital technology for teaching and learning in PETE contexts. The purpose of this study was to explore the relationship between a student-centred digital technology approach and the intrinsic motivation, the learning climate and the academic achievement of physical education PSTs.

Methods

Participants

At the beginning of a first year module titled 'Youth Sport', 110 PSTs (from a four-year BSc in Physical Education at a Spanish University) chose between experiencing (a) a student-centred

digital technology approach characterized by a series of digital technology-based learning activities sequenced throughout the semester (from week one to week 12 and a final examination in week 12) or (b) a non-active approach (same instruction but not digital technology-based learning activities and also a final examination in week 12). Eighty-six PSTs ranging in age from 18 to 32 years of age ($M = 19.69$; $SD = 2.81$) chose the first option (active group) (76 males and 10 females) and 24 PSTs (21 males and three females) chose the second option (non-active group). The teacher educator had more than 10 years' experience teaching undergraduate students and five years' experience integrating digital technology in PETE programmes. The 'Youth Sport' module addressed four topics: (a) models of youth sport participation; (b) sport pedagogy; (c) school sport and (d) youth sport competition.

Background information related to digital technology use

For social media and digital technology to be used as effective learning tools, it is crucial to acknowledge and address PSTs' prior experiences with technology and be aware of such experiences when planning, scaffolding and interacting throughout the process (Mao, 2014). Prior to the design of the student-centred digital technology approach, the technology experiences of the sample were explored through a 20-item (closed and open questions) online survey. Most of the PSTs (96%) were social media users. The most popular outlets were Instagram (78%), Twitter (74%) and Facebook (70%). Fifty-three percent of PSTs reported that they log on to social media many times a day. The most common reason for using social media was to share (self-edited) pictures and videos (87%) and build relationships with peers (74%). A smaller number of participants (14%) used social media for learning (i.e. to collaborate with peers to create documents and/or assessments online). The responses also indicated that 22% were doubtful about the potential of social media and digital technology for learning and motivation. Finally, despite having been taught in primary and secondary school through teacher-led/transmission pedagogies (88%), 93% wished to experience an innovative digital technology approach.

The student-centred digital technology approach

The student-centred digital technology approach was designed based on an adaptation of the five-phase pedagogical guidelines for teaching with emerging technologies (Ng'ambi, 2013), and framed on the connectivism instructional theory premises. That is, learners are to be actively involved in the presentation of a body of knowledge that has been created by collaboration and is meant to be shared (Duke et al., 2013). The approach involved a sequence of 12 digital technology-based learning activities to be completed at various points over the module using web 2.0 presentation makers (see Table 1).

While PSTs were advised to use these web 2.0 presentation makers, they had the choice to use other similar tools that met their previous experience and/or interest. Every digital technology-based learning activity within the approach included an eight-phase cycle (Figure 1). Collaborative work and cyclical assessment for learning (Yan and Brown, 2016), in which individual qualitative feedback on the artefacts was shared between one and three days post-submission, were also part of the process. The directions to complete every activity were shared with the PSTs on a multiple-page multimedia presentation with detailed information (Chuang and Liu, 2012).

Each digital technology-based learning activity began with a thought-provoking question (e.g. is the early specialization pathway key for high sport performance?). PSTs could refine the

Table 1. Description of the digital technology-based learning activities.

Sequence	Title	Tool	Artefact	Grouping
Weeks 1–2	Do you blog?	Blogger [®]	Blog page	Individual
Weeks 2–3	Sampling or not?	Piktochart [®]	Infographic	Pairs
Weeks 3–4	Modify or expire?	Genially [®]	Interactive visual	Pairs
Weeks 4–5	Golden age to start!	Powtoon [®]	Animated video	Pairs
Weeks 6–7	How do you coach?	Piktochart [®]	Infographic	Team of 4
Weeks 8–9	Go go school sport!	Genially [®]	Interactive visual	Team of 4
Weeks 10–11	Sometimes you win . . .	Powtoon [®]	Animated video	Team of 4
Week 12	Cherry on top!	ThingLink [®]	Live image	Individual

question to meet their personal interests and to create a more supportive and engaged learning environment (Diep et al., 2017; Ryan and Deci, 2017). The cycle continued by: (a) searching for information on the internet (to guide the search, the teacher educator recommended different blogs, journal articles, Twitter accounts, etc); (b) curating and sorting the information (gathering the relevant information, adding sense-making); (c) creating the audiovisual artefact; (d) self-assessing the creation using a one- to five-point rubric and qualitative comments; (e) sharing the artefact through Twitter in an attempt to interact in an online conversation with other people interested in the audiovisual creation and (f) posting a reflection about the whole process of creation in learning blogs and through Twitter, always using the module hashtag. The submission process involved the use of the university virtual learning environment (Sakai 10.0).

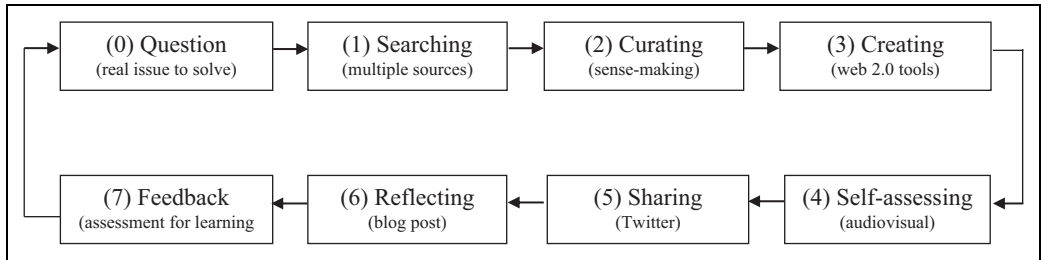


Figure 1. The eight-phase cycle of the student-centred digital technology approach (adapted from Ng’ambi, 2013).

Instructional design

Throughout the semester the teacher educator acted as an ‘activator’ of learning. That is, someone who prompted new learning possibilities or pathways in student-centred environments, mainly through questioning and critical conversation (Goodyear and Dudley, 2015). Both samples of PSTs were in the same class and received the same instruction. Each week the focus of the lecture was to address the weekly learning outcomes, utilizing a variety of teaching strategies (from teacher-led lecturing to more interactive strategies such as discussions and group work). There was also a weekly tutorial (teaching lesson given to a small group of students). The focus of the tutorial was to give PSTs general and specific feedback and learning support on the weekly learning outcomes and/or the web 2.0 tool being used. In addition to formal curricular scheduling, once a week the

teacher educator hosted a ‘happy hour’ in which the PSTs could ask questions and share their impressions of the weekly digital technology-based learning activity using the WhatsApp class back-channel (So, 2016). The teacher educator acted as the moderator and prompted the informal conversation. This back-channel was also used for feedback and supportive messages for PSTs who made such a request.

Data collection

This research was conducted using a mixed-method approach (Johnson and Onwuegbuzie, 2004). Quantitative data were collected exploring the students’ values on intrinsic motivation, learning climate and academic achievement using several instruments. Data were collected and analysed by the second author, who had experience in collecting and analysing data using both quantitative and qualitative methods. The second author had no previous exposure to the PSTs in the study.

Intrinsic motivation. PSTs’ scores on intrinsic motivation were measured using the original version of the Task Evaluation Questionnaire (McAuley et al., 1987). The questionnaire has four subscales: ‘interest/enjoyment’ (seven items), ‘perceived competence’ (five items), ‘perceived choice’ (five items) and ‘pressure/tension’ (five items). The questionnaire items were answered using a Likert scale ranging from one (‘not at all true’) to seven (‘very true’).

Learning climate. PSTs’ learning climate was measured using the original version of the Learning Climate Questionnaire (Williams and Deci, 1996). The instrument was composed of 15 items, with each item requiring a response on a Likert scale ranging from one (‘strongly disagree’) to seven (‘strongly agree’).

Students’ academic achievement. Academic achievement for both samples was measured through a final examination that included a variety of questions (true or false, multiple choice and short-answer) and four sections aligned with the module learning outcomes. For statistical analysis, academic achievement was considered as a manifest variable that was directly measured in both samples through the grade of the final examination.

Students’ tweets. Perceptions arising from students’ tweets about the relationship between the student-centred digital technology approach and the variables of study were analysed using three research questions (Kimmons and Veletsianos, 2016). All tweets and user profiles were shared publicly and were available via public access. Tweets using the module hashtag throughout the autumn semester period and three months after completion of the module, as well as tweets exhibiting a clear connection with the student-centred digital technology approach posted by the PSTs, were collected. To avoid any conflict of interest and participation pressure, it was stressed that the level of engagement in the Twitter conversations would not affect PSTs’ final grades.

Students’ learning blogs. Perceptions arising from PSTs’ blog posts about the relationship between the student-centred digital technology approach and the variables of study were also analysed (Churchill, 2009; Deng and Yuen, 2011). All the PSTs’ blog posts reflecting on the artefact creation process were copied and pasted into a text document for analysis.

Ethical issues

The study gained approval from the ethics committee of the first author's university. Approval and informed consent was successfully completed for the PSTs. Ethical considerations such as privacy and researcher transparency (due to the first author using his own Twitter and WhatsApp account to interact with the students as a part of every digital technology-based learning activity) were addressed. As recommended, issues relative to participant anonymity were specifically noted on the consent form (Goodyear, 2017), and when using verbatim quotations from the students' tweets or blogs data neither a name, Twitter handle nor nickname was included (Gelinis et al., 2017). The only two PSTs who chose not to sign the consent form resided in the non-active group.

Data analysis

The coefficients of internal consistency of the intrinsic motivation, learning climate and academic achievement scales were acceptable (Streiner, 2003). After performing the exploratory factor analysis, we decided not to eliminate any item in order to optimize values of reliability (Timmerman and Lorenzo-Seva, 2011). In the first stage, to explore the scores from both groups, descriptive statistics, multivariate analysis of variance (MANOVA), bivariate correlations and linear regressions were examined. The predictive relationships between learning climate, intrinsic motivation and academic achievement were analysed via a structural equation modelling approach, following the methodological proposal advanced by Kline (2015). In the first step (measurement model), the bidirectional associations among the different variables were inspected by confirmatory factor analysis. In the second step, the predictive effect of learning climate on academic achievement via intrinsic motivation was examined. To perform this multivariate analysis, the maximum likelihood method was applied with the bootstrapping procedure with 5000 iterations, given the violation of multivariate normality assumption (Mardia's coefficient = 397.05, $p < 0.01$) (Kline, 2015). The indices of goodness of fit were considered acceptable when the value of χ^2/df was less than five, incremental indexes (CFI, NFI and TLI) greater than 0.95, RMSEA (root mean square error of approximation) error rate less than 0.08, SRMR (standardized root mean square residual) error rate close to zero and value of p greater than 0.05 (Schreiber et al., 2006). This analysis was conducted using the statistical program AMOS18 (Arbuckle, 2003).

Secondly, using QSR NVivo 11 software, qualitative data from the PSTs' tweets and learning blogs, which were analysed deductively. Directed by Braun and Clarke's (2006) phases of thematic analysis, this included: (a) familiarization with the data (transcribing, reading and re-reading the data); (b) generating initial indicators (coding interesting features of the data in a systematic fashion across the entire data set); (c) collating indicators into existing categories (questionnaires' dimensions); (d) reviewing indicators (checking if the codes work in relation to the allocated category) and (e) defining and naming indicators (refining the specifics of each category and the overall story the analysis tells). The final data source captured 1169 tweets (11,608 words) and 110 students' blogs (12,047 words).

Trustworthiness was supported through continuous feedback, member checks and the participative analysis of two researchers (first and second author) and one independent researcher (third), as they reviewed and refined the generated indicators. Three means of legitimizing the mixed-methods design were pursued (Onwuegbuzie and Johnson, 2006). We addressed: (a) the *inside-outside* concept – that is, the extent to which the researcher accurately presents and appropriately

Table 2. Research questions, data collection and data analysis.

Research question	Data collection	Data analysis
(1) What is the relationship between the student-centred digital technology approach and the pre-service teachers' intrinsic motivation?	Task evaluation questionnaire Students' tweets Students' learning blogs	Descriptive statistics Multivariate analysis of variance (MANOVA) and effect size (η^2) Thematic coding
(2) What is the relationship between the student-centred digital technology approach and the learning climate?	Learning climate questionnaire Students' tweets Students' learning blogs	Descriptive statistics Multivariate analysis of variance (MANOVA) and effect size (η^2) Thematic coding
(3) What is the relationship between the student-centred digital technology approach and the pre-service teachers' academic achievement?	Final examination (for both the active and the non-active sample) Students' tweets Students' learning blogs	Descriptive statistics Multivariate analysis of variance (MANOVA) and effect size (η^2) Thematic coding
(4) What is the relationship between intrinsic motivation, learning climate and academic achievement?	Task evaluation questionnaire Learning climate questionnaire Final examination	Bivariate correlations Linear regressions Structural equation modelling (SEM)

utilizes the insider's views and the observer's views for purposes such as description and explanation; (b) *weakness-minimization*, the extent to which the weakness from one approach is compensated by the strengths from the other approach; and (c) the *multiple-validities* concept. That is, the extent to which addressing legitimization of the quantitative and qualitative components of the study results from the use of quantitative, qualitative and mixed validity types. A summary of the specific research questions, and their connection with the respective analyses and data, are presented in Table 2.

Results

Results are aligned with the four research questions.

What was the relationship between the student-centred digital technology approach and PSTs' learning climate?

Multivariate analysis revealed significant differences between the two groups ($F = 4.44$, $p = 0.03^*$, $\eta^2 = 0.67$) (Table 3). The student-centred digital technology approach produced a more positive learning climate in the active group ($M = 5.57$; $SD = 0.82$). However, learning climate scores of the non-active group were also high ($M = 4.89$; $SD = 0.85$). Eta squared score ($\eta^2 = 0.67$) revealed the digital approach produced a high effect size (Cohen, 1988). In other words, the effect for group differences after the MANOVA accounted for 67% of the group differences. Qualitative data showed a similar trend. Some of the tweets and blog posts from the PSTs in the digital approach group reported a positive learning climate (Table 4), resulting in social interaction and friendly relationships in the class.

Table 3. Descriptive statistics, effect size and lineal regression scores of dependent variables of Sample A, student-centred digital technology approach and Sample B, non-active.

Variables	Sample A M(SD)	Sample B M(SD)	F	p	η^2
Intrinsic motivation ^a					
Interest/enjoyment	4.73(0.98)	3.96(0.82)	4.07	0.03*	0.94
Perceived competence	5.68(0.89)	4.17(0.65)	2.33	0.00*	0.96
Perceived choice	3.86(0.48)	3.84(0.78)	0.03	0.95	0.59
Pressure/tension	2.37(0.85)	2.02(0.52)	1.15	0.28	0.70
Learning climate ^b	5.57(0.82)	4.89(0.85)	4.44	0.03*	0.67
Academic achievement ^c	90.15(0.59)	70.21(0.91)	0.32	0.02*	0.52

M: mean; SD: standard deviation

*Significant difference between Sample A and Sample B ($p < 0.05$).

Cohen's d effect sizes (small < 0.20 ; medium = $0.20-0.80$ large > 0.80).

^aIntrinsic motivation: seven-point Likert scale.

^bLearning climate: seven-point Likert scale.

^cAcademic achievement: scale ranging from A level (above 90%) to D level (less than 50%).

Table 4. Students' tweets and learning blogs. *Research question 1: What was the relationship between the student-centred digital technology approach and the learning climate?*

Categories	Indicators	Students' tweets	%	Students' learning blogs	%
Teaching practice	Teacher implication	'Many thanks to all and keep up the good work! Come on #hashtag!' 'Thanks all #hashtag for your innovative ideas, you have really rocked it!'	45.12	'Full connection with the iGeneration: blogs, infographics, videos, Twitter, etc – I love the happy hour and also the get a continuous feedback on my work, this is really the most important to learn'	33.71
	Student-centred approaches	'I like to work in teams so we can take the decisions in group to create a fancy audiovisual'	09.10	'I felt that we are very important in this methodology, because we are the ones that have to create and decide what info to include, etc.'	22.91
	Leadership skills	'Go #hashtag go, great module and great lecturer, come on!'	07.21	'Captain #hashtag is our guide, our leader – he is being very important to create a great climate – he is always there and is being very supportive!'	15.09

(continued)

Table 4. (continued)

Categories	Indicators	Students' tweets	%	Students' learning blogs	%
Learning climate	Social interaction	'#hashtag! Tell me, what do you think about my blog #hashtag?' 'go go, the happy hour today! Who is joining in?;)'	21.92	'#hashtag has created an optimal emotional engagement between the teacher and the students, we are like a big family;-)'	17.01
	Friendly relationship	'Cheer up friends! Yes we can! top, top;)'	16.65	'I have learned and enjoyed with my #hashtag friends during our teaching-learning process – we are like a team!'	11.28

Note: Percentage (%) relates to the number of times that each Indicator is referenced in the Students' tweets and/or Students' learning blogs

Assertion 1: The student-centred digital technology approach created a collaborative and positive learning atmosphere.

Table 5. Correlation coefficients of dependent variables between Sample A, student-centred digital technology approach and Sample B, non-active.

Variables	Learning climate (2)		Academic achievement (3)	
	Sample A	Sample B	Sample A	Sample B
Intrinsic motivation(1)				
Interest/enjoyment	0.83*	0.51*	0.50*	-0.15
Perceived competence	0.77*	0.45*	0.47*	-0.09
Perceived choice	0.53*	-0.19	0.69*	-0.09
Pressure/tension	0.49*	0.14	0.74*	-0.17
Learning climate(2)	–	–	0.81*	-0.20

*Significant correlation coefficients ($p < 0.05$).

What was the relationship between the student-centred digital technology approach and PSTs' intrinsic motivation?

Statistical results conveyed a positive relationship between the student-centred digital technology approach and PSTs' intrinsic motivation (Table 5). Data reported differences related to interest/enjoyment ($F = 4.07, p = 0.03^*, \eta^2 = 0.94$) and perceived choice ($F = 2.33, p = 0.00^*, \eta^2 = 0.96$) in favour of the digital technology approach group ($p < 0.05$). However, no differences were detected for perceived choice ($F = 0.03, p = 0.95, \eta^2 = 0.59$) and pressure/tension ($F = 1.15, p = 0.28, \eta^2 = 0.70$) between both groups. Some of the intrinsic motivation indicators produced from PSTs' tweets and blog posts evidenced PSTs' perceived learning, perceived self-confidence, perceived enjoyment and meaningful learning, but also signs of challenge and perceived pressure (Table 6).

Table 6. Students' tweets and learning blogs. Research question 2: What was the relationship between the student-centred digital technology approach and the pre-service teachers' intrinsic motivation?

Categories	Indicators	Students' tweets	%	Students' learning blogs	%
Perceived competence	Perceived learning	'Now I really feel more competent by creating audiovisuals; I have learned to use Genially and Powtoon to create my own stuff!'	13.33	'I perceive that I have developed my digital competence. Now I know how to improve my blog, and have learnt to use Powtoon, Genially and Piktochart'	15.03
	Perceived self-confidence	'First challenge completed #hashtag, I got it!'	05.13	'Because I was doing it very well, I decided to explain my #hashtag classmates an idea'	07.01
Interest/enjoyment	Perceived enjoyment	'The #hashtag effect! I'm pumped! ;)'	15.05	'#hashtag we are having too much fun by doing the socio-digital technology-based tasks'	09.88
	Encouragement support	'Congratulations for this new challenge! Go go go, what else! Ready to go!'	08.56	'I encouraged you all to continue achieving challenges #hashtag!' 'See you in the happy hour this week!'	11.92
	Interesting approach	'With enthusiasm to start this second challenge, everything is being very interesting at the moment #hashtag'	04.21	'It's very interesting that we all are part of some kind of community of students learning to learn through our own Personal Learning Environments (PLE)'	08.54
	Amazing methodology	'I have been fully motivated along the twelve weeks it's a very shame #hashtag comes to an end!:-('	03.99	'To be honest, I wouldn't have never thought that my peers and I could have this level of engagement by living this amazing methodology'	10.33
	Novelty of the approach	'Can't wait to start the second challenge! First time I faced with this tech-challenge! I like #hashtag'	09.73	'In #hashtag the protagonists are us! The very best is that we have never designed and produced infographics to be shared. I love this!'	13.11
Perceived choice	Meaningful learning	'We like that we can choose information from one desired content from the internet to learn and to create each audiovisual presentation!'	18.08	'During the design of this mini-challenge I have gathered just the relevant information on the mini-basket. I will share this audiovisual with other coaches in my club :-)!'	05.41

(continued)

Table 6. (continued)

Categories	Indicators	Students' tweets	%	Students' learning blogs	%
Pressure/ tension	Perceived transferability	'I truly enjoy that we were able to modify the initial question – I think that was very helpful and applicable to other subjects'	06.88	'Searching and sorting the information is something that we have to do in many other modules, so we can apply information related to other subjects too!'	06.10
	Challenging methodology	'I feel pressured when I'm working on the so demanding tasks, because I don't really know what information to include'	05.19	'#hashtag has a high impact on our learning! My intention is to improve my blog every day although it's not being easy. Especially when we have to share our infographic, because nobody replied :-('	04.27
	Boring methodology	'I hate technology! I'm very bad using it!'	02.51	'I'm not a social media user, neither a technology guy, so I don't think these kind of assignments are very useful'	02.05
	Perceived pressure	'I'm anxious while doing the learning activities. Deadlines for submission are very tight'	07.34	'Each mini-challenge it's a new experience. I don't like this because I feel pressured!'	06.35

Assertion 2: Despite some initial resistance and challenges, the student-centred digital technology approach boosted an optimal self-report measure of intrinsic motivation.

#hashtag = module hashtag.

What was the relationship between the student-centred digital technology approach and the PSTs' academic achievement?

Multivariate analysis revealed significant differences between the two groups ($F = 0.32$, $p = 0.02^*$, $\eta^2 = 0.52$) ($p < 0.05$). The student-centred digital technology approach conveyed the positive relationship between this methodology and the final academic achievement in the active group ($M = 90.15$; $SD = 0.59$), i.e. an A score. However, academic achievement in the non-active group was also high ($M = 70.21$; $SD = 0.91$), i.e. a B score. Eta squared scores ($\eta^2 = 0.52$) revealed that the student-centred digital technology approach had produced a high effect size (Cohen, 1988). Qualitative data conveyed a perception of higher academic achievement and improvement in the student-centred digital technology approach group (Table 7).

What was the relationship between learning climate and intrinsic motivation as possible predictors of academic achievement?

Results conveyed a high positive correlation between all dependent variables in the student-centred digital technology approach group ($p = 0.00^*$) (Table 4). In contrast, there were negative

Table 7. Students' tweets and learning blogs. Research question 3. What was the relationship between the student-centred digital technology approach and the pre-service teachers' academic achievement?

Categories	Indicators	Students' tweets	%	Students' learning blogs	%
Measured learning	Higher academic achievement	'With the learning activities, we have achieved better academic achievement, my best grade ever! that's cool!'	21.13	'I do really think that after the first two activities we were all very motivated to create the best audiovisual, to get a high mark – the self-assessment process was very helpful and we have never done it before'	10.05
Perceived learning	Academic achievement perception	'The self-assessment gave us an idea of our learning and achievement every challenge!'	35.80	'I finished this subject with a high knowledge of the module contents. Now I have loads and loads of different ideas to apply when I graduate!'	37.26
	Overcoming	'We feel the improvement week by week, activity by activity!'	43.07	'In every challenge we overcome more and more! The feedback provided was really helpful to learn and improve!'	52.69

Assertion 3: The academic achievement of the pre-service teachers experiencing the student-centred digital technology approach was excellent.

correlations regarding the academic achievement and the other variables in the non-active group. The indices t or indices of goodness of fit obtained in the measurement model (step one) revealed the high existing statistically significant interrelation of the six subscales in the sample of students that experienced the student-centred digital technology approach (X^2 (21, $n = 110$) = 101.88, $p = 0.72$, $X^2/df = 3.42$, $CFI = 0.94$, $TLI = 0.95$, $SRMR = 0.07$). Conversely, lower and negative t scores were found in the non-active group (Figure 2). Results from the structural equation model revealed correct psychometric quality, internal consistency, reliability and the adequacy of the structural model: $\chi^2/df = 2.80$, $TLI = 0.91$, $CFI = 0.91$, $GFI = 0.90$, $RMSEA = 0.03$ and $SRMR = 0.07$ (Figure 3).

Finally, the structural equation model conveyed that learning climate predicted intrinsic motivation ($\beta = 0.71$), and these dimensions, according to the hypothesized model of the relationships, predicted academic achievement ($\beta = 0.73$).

Discussion and implications

There is a need to transform education to make certain that schooling in general, and higher education in particular, becomes more personalized and tailored to individual student learning (Robertson, 2018). Therefore, teacher educators will need to build repertoires of teaching and learning approaches. Students (and PSTs) will need to build a skill-set to know how they can learn best and how they can work collaboratively (Misseyanni et al., 2018). Accordingly, the student-

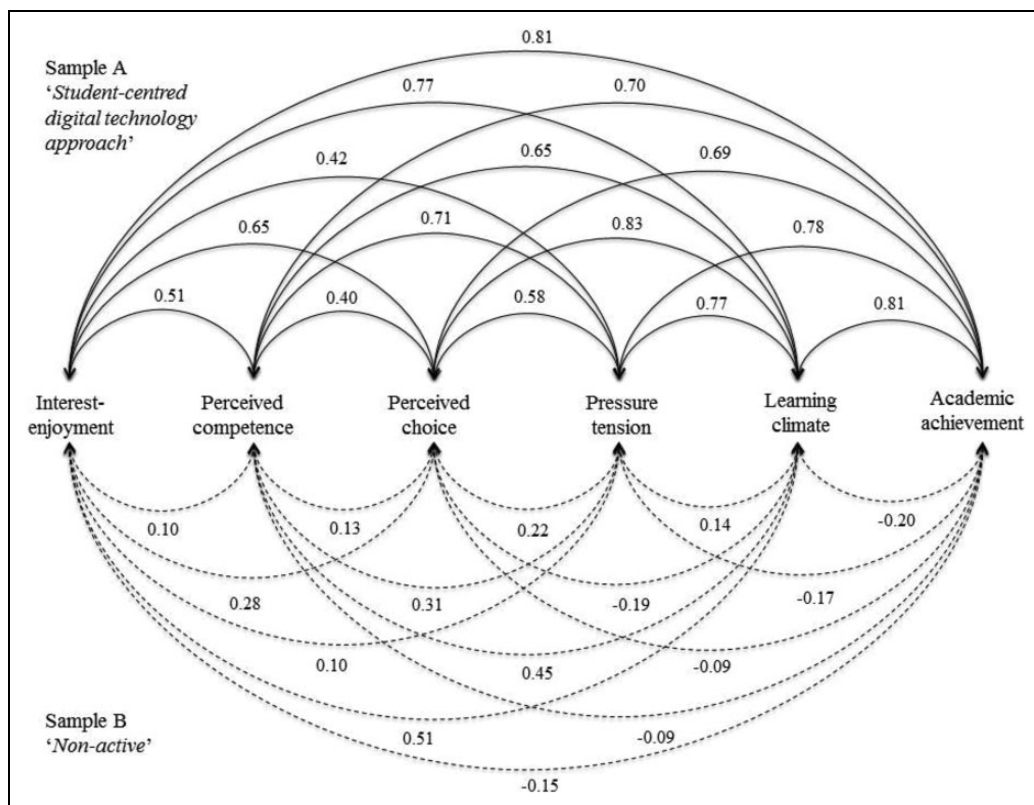


Figure 2. Measurement equation model with standardized coefficients.

centred digital technology approach was an attempt to use digital technology in transformative ways to enrich the physical education PSTs' learning experiences (Henderson et al., 2015; Hung and Yuen, 2010; Ng'ambi, 2013) and is proposed as a possible pedagogy of digital technology to be used in PETE programmes. The student-centred digital technology approach was designed on the premise of connectivism instructional theory. That is, learning is not a matter of transferring knowledge from a teacher to a learner but rather the product of the learner focusing and repeating creative acts of practising something that is relevant and reflecting on this practice (Downes, 2012). As we discussed, one of the principles of connectivism conveys that learning is also a process of connecting information sources and that was the reason why each student-centred digital technology approach involved the PSTs in the process of: (a) searching; (b) curating and sorting; (c) creating; (d) self-assessing; (e) sharing and (f) reflecting (Ng'ambi, 2013).

The results from the data convey that when PSTs were provided with some choice in every learning activity, their intrinsic motivation and perceived competence was elevated (Patall et al., 2008). While we are cautious about the inferences being made, such findings are consistent with previous general education research. As part of the student-centred digital technology approach, PSTs were faced with two main choices: (a) to use other web-based tools to design their artefacts; and (b) to refine the question to allow it to be addressed in every learning activity. While no PSTs

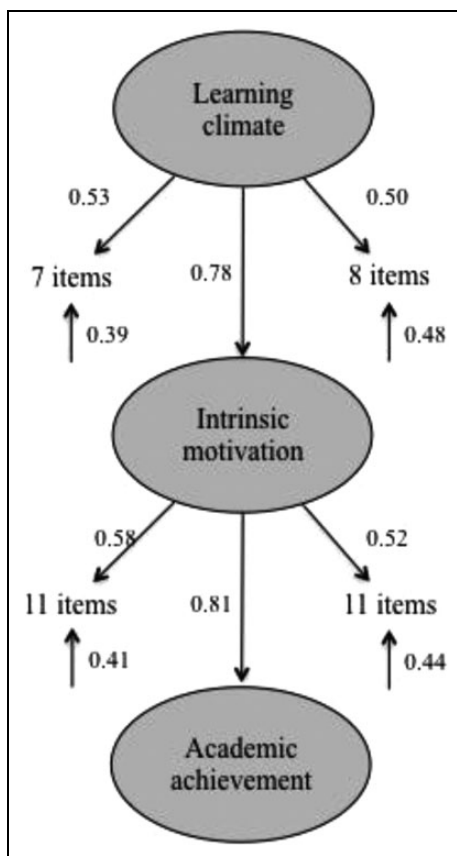


Figure 3. Structural equation model between students' intrinsic motivation, learning climate and academic achievement.

chose a different web-based production tool, 77.9% ($n = 67$) unexpectedly 'filtered' the initial question to meet their personal interests (Diep et al., 2017). Based on constructivist views of knowledge, learning tasks (digital technology-based or not) should have real-world (authentic) relevance and mimic real problems of practice (Robertson, 2018). That was the case in our sample with the choices provided. Some comments from the PSTs (Table 6) supported this finding: 'I truly enjoyed that we were able to modify the initial question' (Student 13 blog); 'The best for me was that I created most of the artefacts about my favourite sport' (Student 82 tweet).

Interestingly, most of the PSTs had not previously used digital technology for active learning purposes and were using the web-based 2.0 tools (Piktochart, Genially and Powtoon) for the first time. The student-centred digital technology approach was a new learning experience to most and they were initially positive towards using digital technology and social networks for educational purposes. Thus, novelty represents a new basic psychological need with an important defining component of intrinsic motivation (González-Cutre et al., 2016). In a similar vein, González-Cutre and Sicilia (2018) advocated for the importance of teachers developing strategies to provide novelty support. Findings also revealed an effect of the student-centred digital technology

approach on the PSTs' perceived competence. The sequence of linked learning activities that took place at various times throughout the semester (Butz and Stupnisky, 2017) could have contributed to this prolonged engagement and perceived competence. The connection between each learning activity from week one to week 12 encouraged PSTs to consider the transference to other topics and knowledge, which in turn resulted in an incremental complexity and learning of the youth sport topic (Robertson, 2018). PSTs' tweets and blog posts confirmed their perceived learning and self-confidence (Gikas and Grant, 2013; González-Cutre et al., 2016; Sun et al., 2018). There is evidence to suggest that choice (Patall et al., 2008), novelty and perceived competence represented three essential aspects of the PSTs' intrinsic motivation.

The student-centred digital technology approach was also appropriate in setting an optimal classroom-learning climate. The teacher educator's implementation and enthusiasm were largely appreciated by the PSTs (Kali et al., 2015). Although setting an optimal learning climate is affected by multiple variables, the individual short-time qualitative feedback that the PSTs received within the cyclical assessment for learning process (Yan and Brown, 2016) appeared to enhance the learning climate. As Tondeur et al. (2012) identified, providing continuous feedback throughout a programme and having PSTs collaborate with peers was key to preparing them for integrating technology in their future classroom. The quality of student-student relationship and teacher educator-student interaction (Giles, 2011) was also crucial to promoting an optimal learning climate. Student-student relationships were promoted in the collaborative groupwork to design and share the artefacts. Teacher educator-student relationships were promoted due to the informal (also collaborative) learning that occurred every week in the 'happy hour'. PSTs were extremely active and engaged with instant messaging in the WhatsApp back-channel. At the same time, they shared their 'digital downsides' (i.e. doubts and difficulties while solving the learning activities) (Selwyn, 2016), and their satisfaction upon completion of the learning activity. Previous research has shown the potential of instant messaging conversations in supporting the co-creation of artefacts, meaning making, motivation and affective support (Timmis, 2012). Interestingly, in the eight-phase cycle of the student-centred digital technology approach, the 'sharing' component was not successful from the perspective of learning and engagement. Given that most PSTs were Twitter users, they were asked to share the designed artefact through Twitter. This was an attempt to interact in an online conversation with both PSTs and physical education teachers interested in the audiovisual creation. Such conversations advocated for the importance of online learning and collaboration for future teachers (Goodyear et al., 2014). Previous research using Twitter for learning with undergraduate students reported that few students use Twitter for social purposes and that a majority of students never use Twitter for perceived learning purposes (Lackovic et al., 2017). Despite adopting some of the 'enablers' that Lackovic et al. (2017) identified to encourage students' participation (i.e. the use of a hashtag, or content that is relevant to students), most of the PSTs posted their tweets to share their artefacts, with no meaningful conversations and engagement. Connectivism offered specific technological opportunities for the learner to be actively involved in their learning by collaborating and sharing (Duke et al., 2013). However, the sharing component was relatively weak in this study.

The academic achievement of the PSTs who experienced the student-centred digital technology approach was higher compared with the non-active sample. Supported by this study, intrinsically motivated students in an autonomy-supportive environment exhibited more creative thinking, higher conceptual understanding and more positive emotions (Jeno et al., 2017). However, it is crucial to be cautious with this assertion. Using structural equation models to analyse social realities could be problematic. The statistical models constructed for such substantive processes

can only be a simplification of the researched reality (Tarka, 2018). In this study, the variable academic achievement is extremely complex and affected by multiple factors. Thus, despite our findings being coherent with the theoretical constructs, the analysed reality is multiple (Barton et al., 2018) and caution must be exercised in determining meaning from the results. Finally, we are aware that a limitation to this study is the inherent weakness of the quantitative research design. Although there were two conditions measured, no pre-test measurements in either condition were carried out. Having a post-test only research design does not account for potential differences across the groups at the start of this study and, therefore, any assertion of change in the variables of interest. As such, some comparison is possible at the end of the intervention, but the internal validity of this design is problematic. Despite this limitation, the mixed-method research design can: (a) provide stronger evidence for a conclusion and corroboration of findings; and (b) add insights and understanding that might be missed when only a single method is used (Johnson and Onwuegbuzie, 2004).

Conclusion

Our study provides support for the use of active learning environments in PETE programmes, where PSTs are involved in creative content production using digital technology. Choice and novelty were two central tenets that conditioned high levels of intrinsic motivation and academic achievement. Furthermore, it is crucial to create a connected environment, with the teacher educator assuming an active role by prompting and motivating the students through digital technology pedagogy. The evidence suggests that the student-centred digital technology approach created a positive learning environment that led to optimal values of intrinsic motivation and academic achievement in physical education PSTs. In other words, learning was best supported when the PSTs were engaged in active, collaborative and relevant digital technology-based learning activities. As a final point, and given the growing role of digital technology in educational policies and new physical education curricula, we advocate for the publication of more research-based experiences on a variety of digital technology pedagogies in PETE programmes. A specific focus would be the transfer of such teaching and learning experiences into physical education teachers' and PSTs' practice. The design, development and sustainability of digital technology pedagogies in PETE is likely to remain a challenge for the PETE community in the coming years.

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