Teachers' concerns about adopting technology-enhanced embodied learning and their mitigation through Professional Development

Abstract

Technology-enhanced embodied learning is argued to have the potential to revolutionize K-12 education. Despite the affordances of technology-enhanced embodied learning, its integration in mainstream education is currently at slow pace. Slow adoption of technological innovation is not a new issue in the education arena. Several factors are contributing to why in-service teachers are being reluctant to adopt educational innovations. This study investigated the concerns of 31 in-service primary education teachers about adopting technology-enhanced embodied learning using the Concerns Based Adoption Model (CBAM). A Professional Development (PD) programme composed of two phases – a Training phase (including experiential workshops) and a Practical phase (including teachers' enactment of technology-enhanced embodied learning in their classrooms) – allowed for the mitigation of these concerns. By the end of the PD programme teachers retained only some high-level concerns, which are essential for the scalability and sustainability of technology-enhanced embodied learning. The study elaborates on the use of the CBAM model and provides a rich description of our PD programme, which can inform future efforts in this area. Taking into account and addressing teachers' concerns through PD lays the groundwork for the successful adoption of technology-enhanced embodied learning to nourish education.

Keywords: Technology-enhanced embodied learning, Concerns-based adoption model, Teacher attitudes, Teacher Professional development, Technology Integration

1. Introduction

Embodied digital learning apps, which compose an emergent category of educational digital apps that integrate bodily movement into the act of learning, are argued to have the potential to revolutionize K-12 education. The springboard for the development of these cutting-edge apps is that motion and bodily involvement can support students' learning due to (a) their affordances for multimodal interactions, (b) the provision of dynamic feedback, (c) the creation of physical representations, as well as (d) their playful nature (Abrahamson & Lindgren, 2014; Antle, 2013, 2018). These innovative apps are grounded in immersive interfaces, while also leveraging the power of motion-based technologies and natural interfaces (e.g., Wii, Xbox Kinect, or Leap Motion), thus creating new educational possibilities (Johnson-Glenberg, Birchfield, Tolentino, & Koziupa, 2014; Johnson-Glenberg, Megowan-Romanowicz, Birchfield, & Savio-Ramos, 2016).

Despite the educational affordances of technology-enhanced embodied learning (see the literature reviews of Georgiou & Ioannou, 2019; Sheu & Chen, 2014; Tran, Smith, & Buschkuehl, 2017), as a contemporary pedagogical approach, its implementation in authentic educational settings is not yet a systematic area of research. The integration of embodied digital learning apps in mainstream education is currently at very slow pace (Ioannou, Georgiou, Ioannou, & Johnson-Glenberg, 2019; Georgiou, Ioannou, & Ioannou, 2019). Slow adoption of technological innovation in schools and careful design for technology and pedagogy integration are not new issues in the education arena (Ioannou, 2018). Lack of professional development, lack of infrastructure, lack of motives, lack of disciplinary teams (instructional designers, educators, educational technologist) working on innovation

are only some of the factors inhibiting the adoption process. With respect to technology-enhanced embodied learning the general lack of Professional Development (PD) programmes for teachers is already documented in the literature (Johnson-Glenberg et al., 2016). Also, little is yet known about teachers' concerns and attitudes towards the adoption of this pedagogy (Quick et al., 2010).

The present paper presents an exploratory case study which first, examines the initial concerns of a cohort of in-service primary education teachers towards the adoption of technology-enhanced embodied learning and second, documents the impact of a PD programme on the mitigation of their concerns.

2. Theoretical Framework

2.1 Defining Technology-enhanced Embodied Learning

Technology-enhanced embodied learning, as contemporary pedagogical approach grounded in the theory of embodied cognition theory, has just started gaining ground during the last decade, due to the emergence of motion-based learning digital apps (Antle, 2013, 2009; Barsalou, 2010; Georgiou & Ioannou, 2019; Kosmas, Ioannou, & Retalis, 2018; Kosmas, Ioannou, & Retalis, 2017). As such, learning via embodied digital educational apps is still a relatively nascent field. This novel pedagogy is supported by the widespread population of affordable motion-based technologies in combination with the emergence of immersive interfaces based on mixed or virtual reality, which have opened the doors for the design of embodied digital learning apps (Enyedy, Danish, & DeLiema, 2015; Johnson-Glenberg et al., 2016).

In its essence, embodied digital learning apps compose an emergent category of digital environments, which integrate gestures or even full-body movements into the act of learning (Johnson-Glenberg, Savio-Ramos, & Henry, 2014). According to

Johnson-Glenberg and her colleagues (2014, 2016), embodied digital learning apps are defined by three main aspects: (a) the high amount of sensorimotor engagement, as achieved through bodily motion, (b) the high amount of gestural congruency, which is achieved through the relevance of the gestures with the content to be learned, as well as (c) the high amount of immersion, which is influenced to a great degree by the type and configuration of the content's display.

Taking into account these affordances, embodied digital learning apps are argued to have the potential to revolutionize K-12 education. Importantly, these arguments are warranted by empirical studies and literature reviews supporting that embodied digital learning apps can contribute to students' learning gains. For instance, as part of a recent literature review, Georgiou and Ioannou (2019) have found a significant corpus of empirical studies contextualized in K-12 STEM education, providing support for students' gains in knowledge acquisition and conceptual understanding in technology-enhanced embodied learning experiences. At the same time, prior review efforts and empirical studies have indicated the positive impact of embodied digital learning apps in terms of promoting cognitive, emotional, social and psychomotor learning gains for students with disabilities in special or inclusive educational settings (e.g. Kosmas et al., 2018; Kosmas et al., 2017; Kourakli, Altanis, Retalis, Boloudakis, Zbainos, & Antonopoulou, 2017; Martínez-Monés, Villagrá-Sobrino, Georgiou, Ioannou, & Ruiz, 2019; Sheu & Chen, 2014). As such, due to their educational affordances and wide-ranging areas of applicability, embodied digital learning apps are highly intriguing to researchers, instructional designers, technology specialists and educators.

2.2 Teacher PD in relation to Technology-enhanced Embodied Learning

Despite the affordances of technology-enhanced embodied learning, its mass deployment in schools seems infeasible (Ioannou et al., 2019; Georgiou et al., 2019). However, this is not surprising given that embodied pedagogies are usually neglected in the theorizing of pedagogies for teacher education (e.g., Estola & Elbaz-Luwisch, 2010; Forgasz, 2015; Macintyre Latta & Buck, 2008). Instead, according to McDonough, Forgasz, Berry, and Taylor (2016), one of the prevalent issues in teacher education is the "overemphasis on technical rational views of learning to teach" which in contrast to embodied pedagogy tends to separate "mind, body, and emotions" (p. 433). As such, prospect teachers are not familiarized with the notion of embodied learning, as a powerful pedagogy which according to Nguyen and Larson (2015) invites "learning that joins body and mind in a physical and mental act of knowledge construction" (p. 332).

At the same time, when focusing on technology-enhanced embodied learning, according to Karakostas et al. (2017), embodied digital learning apps are often developed for research rather than educational purposes while, importantly, teachers also do not have confidence in using them. Furthermore, existing embodied digital apps have usually derived from a designer-oriented approach, in which teachers and their students are excluded from the development process (Antle, 2013). However, this top-down design approach, not only results in embodied digital learning apps which are unlinked from the education curriculum (Karakostas et al., 2017; Malinverni, Mora-Guiard, Padillo, Valero, Hervás, & Pares, 2017) but at the same, deprives teachers of an the opportunity to develop an understanding of the relationship between the learning pedagogy, the student activity and the instructional goals (Kyza & Georgiou, 2014; Kyza & Nicolaidou, 2017).

It seems therefore that there is an urgent need for strengthening teachers' Information and Communication Technologies (ICT) skills and confidence for integrating cutting-edge technologies, such as embodied digital learning apps, in their school classrooms. This priority has long been of increased attention in the European policy agenda (European Schoolnet, 2017), given the under-utilization of educational technologies in the classroom which can have a promising value. According to Fugate, Macrine, and Cipriano (2018) while many teachers have noted the positive effects of embodied learning, they are often confused as to how embodied leaning can be effectively achieved in the classroom. In this context, Johnson-Glenberg, Megowan-Romanowicz, Birchfield, and Savio-Ramos (2016) argued that teachers should receive specific training on embodied digital learning apps, preceding the use of these technological innovations, for the successful enactment of technology-enhanced embodied learning.

2.3 The Concerns Based Adoption Model (CBAM)

A significant corpus of prior research has shed light on the complex nature of teachers' attitudes towards the adoption of ICT-related educational innovations (Albirini, 2006; Cavas, Cavas, Karaoglan, & Kisla, 2009; Kao & Tsai, 2009). Teachers' attitudes have been previously defined as positive or negative emotional reactions towards a particular object (in our case, towards technology-enhanced embodied learning); teachers' concerns are, in turn, defined as a type of positive or negative attitudes (de Vocht, Laherto, & Parchmann, 2017).

The present study was based on the Concerns Based Adoption Model (CBAM), which has been used to classifying teacher' concerns about various educational innovations and to help them through the adoption process (Hall & Hord,

2006). Overall, according to the CBAM model, teachers' concerns are usually related the following stages: (1) Information stage (Stage 1), Personal stage (Stage 2), Management stage (Stage 3), Consequence stage (Stage 4), Collaboration stage (Stage 5), and Refocusing stage (Stage 6) (Bailey & Palsha, 1992; Shoulders & Myers, 2011). In its essence, CBAM provides a trajectory for classifying different types of concerns in relation to an innovation ranging from low-level concerns (Stages1-3), to high-level concerns (Stages 4-6) (Hall, George, & Rutherford,1977; Gene, George, & Stiegelbauer, 2013).

However, as teachers experience various concerns of different stages simultaneously, researchers have also derived concern profiles" which take into account the effect of all concern stages collectively. Prior studies in the field have formulated and reported, for instance, on a number of concern profiles such as the "Worried, the "Co-operator", the "Opponent", the "Overachiever", the "Ideal implementer" or the "Resistor" (e.g. Bitan-Friedlander, Dreyfus, & Milgrom, 2004; Hollingshead, 2009). Overall, the CBAM model provides a lens for conceptualizing the adoption of a given educational innovation, in our case the adoption of technology-enhanced embodied learning, from the teachers' point view, by allowing useful insights in their concerns. In this context, Quick et al. (2010) have stated that, in order to successfully support teachers in adopting embodied digital environments, teachers' personal concerns should be deeply understood on a personal level.

3. Rationale and Research Questions

Understanding teachers' concerns about a technological and pedagogical innovation, can help to support teachers through the adoption process. In this spirt, the present study adopted the CBAM model to investigate the concerns of 31 in-service primary

education teachers before and after their participation in a Professional Development (PD) programme. Our hypothesis was that teachers' concerns would be mitigated due to their participation in the PD programme. In particular, this study addressed the following research questions: (a) Which are the main teachers' concerns about the adoption of technology-enhanced embodied learning prior the PD programme?, and (b) How did participation in the PD programme affect teachers' concerns about the adoption of technology-enhanced embodied learning?

4. Methods

4.1 Participants

A total of 31 in-service teachers in primary education participated in the PD programme. In particular, twenty-five teachers were female (81%) and six of them were male (19%). Table 1 presents the demographics of the sample.

Table 1
Demographic aspects and sample distribution

Demographic aspects		**Absolute number of teachers (n)**	**Percentage of teachers (%)**
Gender	Male	25	81%
	Female	6	19%
Education settings	General ed.	19	61%
	Special ed. (SEN)	11	36%
	Both settings	1	3%
Teaching experience	1-5 years	3	10%
	6-10 years	7	23%
	11-15 years	9	29%
	16-20 years	10	32%
	21^{+} years	2	6%
Prior knowledge of embodied learning	Yes	10	32%
	No	21	68%

4.2 The Professional Development (PD) Programme

Our Professional Development (PD) programme adopted a cyclical framework, which was based on a prior PD model used in previous studies in the field (e.g. Kyza & Georgiou, 2014; Kyza, Hadjichambis, Georgiou, & Agesilaou, 2017). The PD programme was enacted in the context of the [European project] (omitted for blind review). The framework was organized in two sequential phases – a *Training* and a *Practical* phase – placing teachers in four sequential roles: *Learners*, *Designers*, *Innovators*, and *Reflective practitioners* (Figure 1). The overall goal of the PD programme was to support teachers in acquiring skills and confidence in adopting technology-enhanced embodied learning, for addressing the needs of all children in inclusive education contexts.

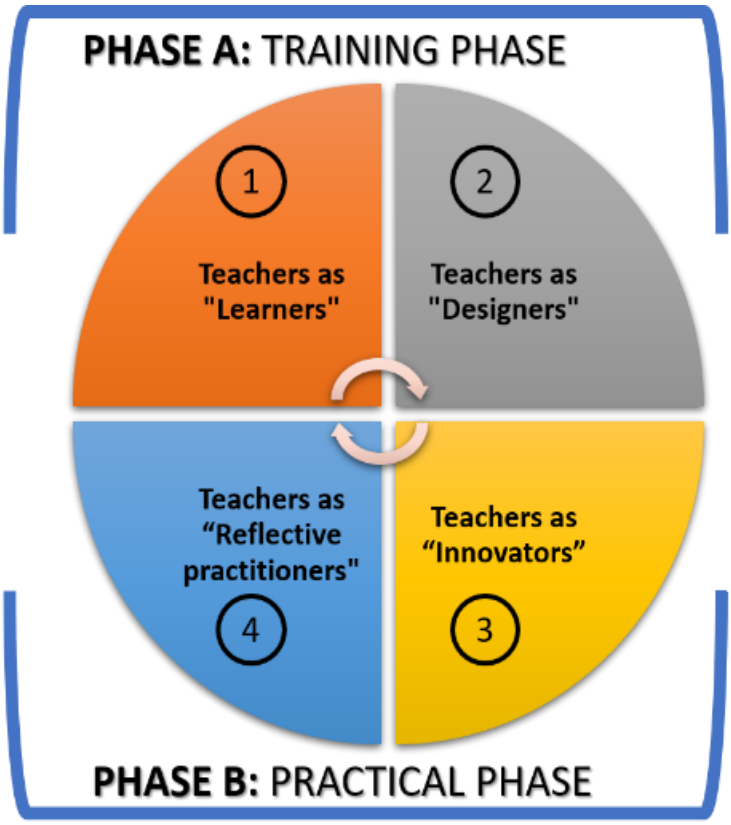

Figure 1. A diagrammatic representation of the PD programme of the [European project] (omitted for blind review).

As part of the *Training phase* (Phase A), teachers assumed the roles of *"Learners"* and the role of *"Designers"* to expand their theoretical knowledge and skills on the topic. The *Training phase* (Phase A) was realized via three experiential workshops of 5 hours each, from October-December 2018.

When taking the role of *"Learners"*, teachers were introduced to the pedagogy of technology-enhanced embodied learning and experienced a variety of embodied digital learning apps (e.g., KINEMS games-https://www.kinems.com/) from the students' viewpoint (Figure 2), via a set of experiential activities. In particular, the teachers assumed the role of students and played with four different digital embodied learning games, reflecting on the games' content and learning goals interface design, and embodied affordances. Through this situation, teachers were implicitly exposed to notion of "learning via embodied interaction".

Figure 2. Teachers as *"Learners"* using embodied digital learning apps

Subsequently, the teachers assumed the role of *"Designers"*. This stage marked the formation of disciplinary teams (e.g. SEN teachers with general education

teachers), which were tasked to identify curriculum areas for the integration of a selected embodied digital app. The teams were then, tasked to design a lesson plan for the integration of an embodied learning game in their classrooms (Figure 3). Overall, the teachers collaborated, discussed and reflected in their teams on the effective integration of "technology-enhanced embodied learning" in their classrooms.

Figure 3. Teachers as *"Designers"* developing their lesson plans

As part of the *Practical phase* (Phase B) teachers were involved in a set of school pilots, assuming the roles of *"Innovators"* and *"Reflective practitioners"* to apply, in praxis, the knowledge and skills they had gained during the previous phase.

When taking the role of *"Innovators"* the teachers had to enact the lessons plans they had designed in the previous phase (Figure 4) and assess the impact of technology-enhanced embodied learning on their students. In order to do so, the teachers were provided access to the technological equipment (i.e., Kinect cameras) and the digital apps. The teachers' interventions took, on average, three 40-minute lessons. It should be noted that, as part of the interventions, teachers engaged in action research, as they participated in a pre-post research design to evaluate the impact of

their interventions on their students' learning gains (academic, cognitive, social and emotional learning outcomes).

Figure 4. Teachers as *"Innovators"* integrating technology-enhanced embodied learning in their classrooms

Finally, when taking the role of *"Reflective Practitioners"* teachers were invited to reflect on their school pilots as well as to share their experiences with their colleagues (Figure 5). The reflective activity took place during the last experiential workshop which had a duration of five hours. As part of the activity, which also served as a focus group, the participating teachers were asked to reflect on their school pilots in order to report and discuss: (a) the Strengths (Positive elements), (b) the Weaknesses (Negative elements), (c) the Opportunities (Unexpected positive elements) and (d) the Threats (Unexpected challenges) emerged during the implementations. The reflective activity concluded with a discussion focusing on the distillation of the "Best practices", which emerged collectively from all the implementations, in order to support the endeavors of other teachers who might adopt technology-enhanced embodied learning in their classrooms, in the future.

Figure 5. Teachers as *"Reflective practitioners"* reflecting on their school pilots

This phase was realized via a set of school pilots from January-April 2019 (during this period the participating teachers enacted their lesson plans and assess the learning experience of their students), as well as via the 5-hour reflective workshop.

4.3 Instrumentation and Data Collection

The Stages of Concern (SoC) is a validated and well-known questionnaire (Hall, George, & Rutherford, 1977) that can be used to explore the concerns of innovation adopters (Hall & Hord, 2006) in order to understand and support them better. A revised version of the SoC questionnaire was adapted from de Vocht et al. (2017). The SoC consisted of 30 items and used a 5-point Likert (measuring agreement) scale for capturing teachers' concerns on six concern stages (Table 2). Agreeing with most items, presents a high concern in each concern stage. Each item of the SoC questionnaire corresponded to a concern stage (Information, Personal, Management, Consequence, Collaboration, Refocusing), while each concern stage was represented by a sum of five items

Table 2
Questionnaire Dimensions, Subscale Details and Indicative Items

Levels of concerns	**Stages of concerns**	**Description**	**Indicative item**
Low-level concerns (Self- and task concerns)	1. Information	Teachers feel that they do not have enough information about the innovation	I have limited knowledge of technology-enhanced a embodied learning
	2. Personal	Teachers feel that are not skillful enough to handle the innovation	I am concerned about my skills to handle the teaching that technology-enhanced embodied learning requires
	3. Management	Teachers feel that they do not have enough time, resources or support to adopt the innovation	I am concerned about not having enough time to implement technology-enhanced embodied learning
High-level concerns (Impact concerns)	4. Consequence	Teachers feel that the innovation might prove harmful for their students	I am concerned about students' attitudes toward technology-enhanced embodied learning
	5. Collaboration	Teachers feel that may be difficult to find colleagues to work with for the innovation	I would like to help my colleagues in their teaching about technology-enhanced embodied learning
	6. Refocusing	Teachers feel concerned about the possibility to improve and refine the innovation further	I would like to determine how to develop the approach of teaching via technology-enhanced embodied learning

In addition, as in prior empirical studies using the SoC questionnaire (e.g. de Vocht et al., 2017; Quick et al., 2010), an open-ended question was appended to the questionnaire in order to validate teachers' concerns as well as to shed more light in the quantitative data collected. More specifically, the following open-ended question was added in the questionnaire: What are your main needs in relation to adopting technology-enhanced embodied learning, at this point?

The questionnaire was administered in three different timepoints to capture the trajectory of teachers' concerns during the PD programme. In particular, the questionnaire was completed:

- At the outset of the PD programme (Pre-test)
- After the completion of the Training phase (Post-test)
- After the completion of the Practical phase (Pospost-test)

4.4 Data Analysis

To investigate the participating teachers' concerns about the adoption of technology-enhanced embodied learning, we followed the data analysis method proposed by de Vocht et al. (2017) according to which the intensity of each concern stage was calculated by summing up the values on the responses in the items of the respective concern stage. In particular, "strongly agree" was scored with +2 while "strongly disagree" with -2. Likewise, "slightly agree" "slightly disagree" was scored with +1 or -1 respectively, while "neither agree nor disagree" was scored with 0.

Descriptive statistics were used to investigate the pre-test concerns in each stage for the total sample (n=31). In addition, pre-test teachers' concerns were also investigated at an individual level, following the outlined method of the SoC questionnaire analysis, in order to recreate the "stages of concern profile" for each teacher. This profile provided an insight of the teachers' concerns at the outset of the PD programme and was compared to the already known concern profiles reported in the literature e.g. the "Worried, the "Co-operator", the "Opponent" (e.g. Bitan-Friedlander, Dreyfus, & Milgrom, 2004; Hollingshead, 2009).

For the comparison of teachers' concerns at the different timepoints of the PD programme (pre-test, post-test, postpost-test) the Friedman test was employed. This is

a non-parametric test suited for comparing a group's difference across repeated measures over time when the sample is relatively small and the data dot not follow a normal distribution, as in our case. The Wilcoxon signed-rank test, with the relevant Bonferroni adjustment, was also employed on the different comparisons of timepoints, to investigate when the differences actually occurred.

Finally, the data collected by the participating teachers at the open-ended question per timepoint (PreTest, PostTest, PostpostTest) were analyzed using a top-down thematic analysis approach. That is, our thematic analysis was theoretically driven by the Concerns Based Adoption Model (CBAM) and it was guided by our research focus in classifying teachers' self-reported needs according to the concern stages: (a) Information, (b) Personal, (c) Management, (d) Consequence, (e) Collaboration and (f) Refocusing.

5. Findings

5.1 Teachers' Initial Concerns and Concerns Profiles

Figure 6 presents the distribution of the initial concerns' intensities for the total teachers' sample. Medians are represented with horizontal lines, the boxes represent the quartiles closest to the medians, while the outliers are represented with dots, or asterisks (in the case of extreme outliers).

Overall, according to the diagram the stages of *Collaboration* and *Information* had the highest intensity. In contrast, the *Personal*, *Management* and *Consequence* stages had the lowest intensity. This picture of the data often resembles or approaches the *"Co-operator"* profile (see for instance de Vocht et al., 2017).

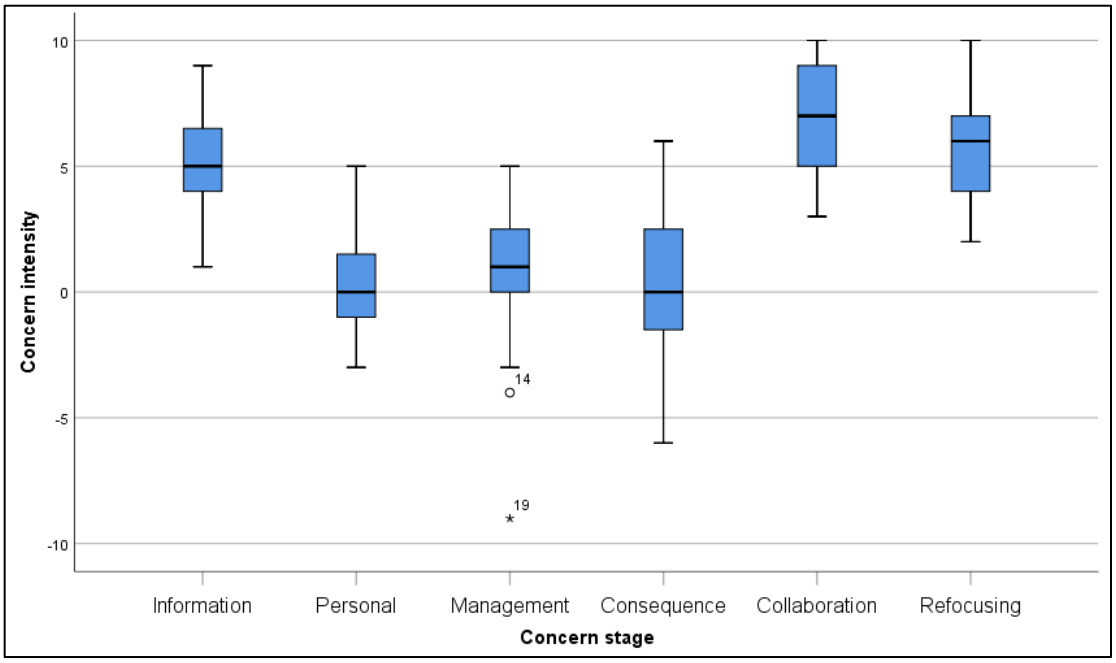

Figure 6. Distribution of concern stage intensities of 31 teachers

Indeed, when identifying the SoC individual profiles for the participating teachers, by comparing the relative intensities of teachers concern stages, the participating teachers approached the *"Co-operator"* profile, with one difference. According to the *"Co-operator"* profile, the intensity of the *Consequence* stage is usually higher, while in our case for some of the participating teachers was relatively low. This means that most of the participating teachers were, initially, more concerned about the information and the collaboration aspects, which is crucial for the innovation, as these teachers were seeking information and were willing to collaborate.

5.2 Comparison of Teachers' Concerns across Time

Taking into account the relatively small sample as well as that the data collected were not following a normal distribution, we used the Friedman non-parametric test, to

identify any potential differences in teachers' concerns across timepoints (Pre-test, Post-test, Postpost-test).

The Friedman test indicated that, across time, there were not statistically significant difference in the *Personal* stage $\chi^2(2) = 1.298$, $p = 0.593$, in the *Management* stage $\chi^2(2) = 0.689$, $p = 0.709$ as well as in the *Consequence* stage $\chi^2(2) = 2.469$, $p = 0.291$. However, the Friedman test indicated that there was statistically significant difference in the *Information* stage $\chi^2(2) = 12.094$, $p = 0.002$, in the *Collaboration* stage $\chi^2(2) = 8.760$, $p = 0.013$ as well as in the *Refocusing* stage $\chi^2(2) = 7.309$, $p = 0.026$, across time.

Post hoc analysis with Wilcoxon signed-rank tests was conducted ($p < 0.017$ with Bonferroni adjustment) indicating that there was a decrease in the concern intensities in all the concern stages between the outset of the PD programme (Pre-test) and the completion of Phase A: Training phase (Post-test), as well as between the completion of Phase A: Training phase (Post-test) and the completion of Phase B: Practical Phase (Postpost-test). However, the decrease was statistically significant only between the outset of the PD programme (Pre-test) and the completion of Phase B: Practical Phase (Postpost-test), in the three concern stages indicated by the Friedman test. In particular, as presented in Table 3, there was a statistically significant decrease in concern intensities in the stages of *Information*, *Collaboration* and *Refocusing* between the outset (Pre-Test) and the end of the PD programme (Postpost-test).

Table 3
Paired-samples Comparison for the Difference between the Pre-test and the Postpost-test Concern Stage Averages

Stages	Paired differences			Z	Significance
	Mean	SD	SEM		
Information	-3.11	2.93	.71	-3.03	.002*
Personal	-0.76	2.22	.54	-1.44	.151
Management	-0.71	5.03	1.22	-0.85	.395
Consequence	-1.30	4.33	1.05	-1.70	.090
Collaboration	-1.99	3.04	.74	-2.54	.011*
Refocusing	-2.18	2.83	.69	-2.69	.007*

Note. *Statistically significant differences, according to the significance level set at $p < 0.017$, are marked with an asterisk

5.3 Teachers' Needs

According to the teacher responses in the open-ended questions it becomes evident that, during the PD programme, the participating teachers moved through the developmental series of the concern stages (see Table 4).

Table 4
Teachers' Needs per Concern Stage across the Duration of the PD Programme

Teachers' needs per concern stage	Outset	After the Training Phase	After the Practical Phase
Information	**32**	**0**	**0**
Information about the PD programme	19	0	0
Information about the embodied pedagogy	8	0	0
Information about the embodied cognition theory	4	0	0
Information about inclusive education	1	0	0
Personal	**12**	**4**	**0**
Improvement of teaching strategies	4	0	0
Improvement of ICT skills	8	4	0
Management	**2**	**24**	**6**
Examples of teacher materials/educative resources	1	4	1
Development/improvement of lesson plans	1	13	0
Support on classroom orchestration issues	0	7	5
Consequence	**4**	**4**	**0**
Improvement of students' learning gains	1	2	0
Improvement of students' emotional development	1	0	0
Improvement of students' learning engagement	2	2	0

Collaboration	**2**	**8**	**0**
Networking with other teachers	1	0	0
Networking with researchers	1	0	0
Social interaction / Exchange of ideas	0	8	0
Refocusing	**2**	**0**	**21**
Access in technological equipment	1	0	5
Access in embodied digital learning apps	1	0	8
Improvement of embodied technologies	0	0	1
Continuous professional development	0	0	5
Scalability of school pilots	0	0	2

Note. The table presents the absolute number of teachers' statements categorized per need and concern stage

In particular, at the outset of the PD programme, the teachers' needs were mostly related to the *Information* and *Personal* concerns stages. For instance, focusing on the *Information* stage, teachers expressed their need for receiving more information about the PD programme per se (its structure, its requirements etc.), the embodied pedagogy or the embodied cognition theory. E.g.

I would like to be informed about the content of the PD programme, the theoretical background of embodied cognition and the pedagogical framework of embodied learning.

Female, Grade 1, General Education

Likewise, focusing on the *Personal* stage, the teachers reported their need for improving their teaching strategies and ICT skills. E.g.

I would like to find out more in order to improve my teaching practices as well to be able to use these educational technologies more effectively in my classroom.

Female, Special Unit, Special Education

Subsequently, at the end of the Training phase (Phase A), and just before the Practical phase (Phase B) the teachers' needs were mostly related to the *Management* and

Collaboration stages. For instance, focusing on the *Management* stage, the teachers expressed their need for developing or improving their lesson plans, for receiving examples of teacher materials and educative resources on the technology-enhanced embodied learning, as well as support on classroom orchestration issues (e.g., technology integration of the embodied digital learning apps, classroom set-up, technical tips etc.). E.g.

I would like to receive some guidelines about my intervention contributing to the effective integration of the embodied learning technologies and to the successful engagement of all the students.

Female, Grade 2, General Education

On the other hand, focusing on the *Collaboration* stage, the teachers expressed their need for social interaction and exchange of ideas to better prepare themselves for their school pilots. E.g.

I would like to receive feedback from my colleagues about my lesson plans as well as to exchange ideas, views and experiences.

Female, Grade 3, General Education

Finally, by the end of the PD programme, after the completion Practical phase (Phase B), the teachers' needs were mostly related to the *Refocusing* stage. For instance, at this timepoint teachers' needs were mostly about their need to have access in the technological equipment (given that for their school pilots they had borrowed equipment from our research lab), and to additional embodied digital learning apps in order to be able to contribute to the scalability of the innovation. E.g.

I would like to have the necessary infrastructures in our school, Kinect cameras, as well as access additional embodied digital apps.

Male, Grade 5, General Education

Likewise, as the teachers reported, they would like to have additional opportunities for continuous professional development in order to be able to contribute to the sustainability of the innovation. E.g.

I would like to receive continuous updates and training opportunities in relation to the technology-enhanced embodied learning.

Female, Grades 3 and 4, General Education

6. Discussion

The integration of innovative technology and pedagogy, such as technology-enhanced embodied learning, into the classroom and the utilization of related educational technologies, has been a priority of increased attention for the European policy agenda (2017). Our exploratory study on teachers' concerns about technology-enhanced embodied learning sheds light on aspects which are very likely to have a significant impact on the adoption and integration processes. As little is still known about the integration of technology-enhanced embodied learning in our educational systems, such an exploration on teachers' concerns provides a necessary starting point for future developments in curricular work, teacher professional development, and educative materials on the topic (de Vocht et al. 2017).

The first goal of this study was to investigate teachers' initial concerns and concern profiles about technology-enhanced embodied learning. According to our findings, our in-service teachers appeared to belong in the "Co-operators" concern

profile. This finding is aligned with prior studies on other educational innovations (Overbaugh & Lu, 2008; Shoulders & Myers, 2011). Importantly, as reported by de Vocht et al. (2017), "having many Co-operators at the beginning of the adoption process is productive for an innovation, as these individuals seek information and possess a willingness to collaborate yet have relatively few personal and management concerns" (p.333).

The second goal of this study was to investigate the effect of a PD programme, taking place in the context of the [European project] (omitted for blind review). The PD programme was a long-term one as it covered the whole school year and it was divided in two main phases. Initially, the PD programme started with a Training phase (Phase A) during which teachers had the opportunity to expand their theoretical knowledge and skills on technology-enhanced embodied learning via the participation in a sequence of experiential workshops. Subsequently, the PD programme continued with a Practical phase (Phase B), during which the participating teachers were involved in school pilots, to apply, in praxis, and deepen the knowledge and skills they had gained during the previous phase.

Our hypothesis was that, as in previous PD programmes, teachers concerns would be mitigated (Kapustka & Damore, 2009; Long & Constable, 1991; Liu, 2005). According to our findings, indeed the PD programme had a positive effect, as it contributed to the decrease of the participating in-service teachers' concerns. However, this impact became statistically significant only when comparing teachers' concerns at the outset of the PD programme and the completion of Phase B, signaling the finalization of the PD programme. This finding provides empirical substantiation and expands research-based conclusions from previous professional development projects, all pointing to the need to engage teachers in extended professional

development experiences (Kyza & Georgiou, 2014; Kyza, & Nicolaidou, 2017; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2009), up to (and including) the stage of application and enactment in the classroom. In other words, our study expands the findings of previous studies supporting that PD programmes are much more effective when combining not only a training part but also a practical part, allowing teachers to implement educational innovations in their classrooms (Goldman et al., 2019; van der Valk & de Jong, 2009).

Finally, our results were also supported by teachers' responses in relation to their needs, shedding more light on the trajectory of teachers' concerns during the duration of the PD programme. Overall, according to the teachers' needs it seems that, during the PD programme, the participating teachers moved through the six concern stages. In particular, while at the outset of the PD programme teachers' needs were mostly related to the low-level concern stages (e.g., Information and Personal stages) by the end of the PD programme their needs had shifted to high-level concerns (e.g., Collaboration and Refocusing stages). This finding also documents the successful implementation of our PD programme. In particular, according to de Vocth et al. (2017) the low-level stages are considered less valuable for an educational innovation, while the high-level stages are only possible when the low-level concerns are resolved. These high-level concerns are essential for the scalability and sustainability of an educational innovation – in our case of technology-enhanced embodied learning.

However, despite the positive effect of the PD programme on teachers' low-level concerns it is important to mention that by the end of the programme most of the teachers' high-level concerns remained unresolved. In particular, the Refocusing concern stage reflects teachers' needs for continuous professional development and for access to additional embodied digital learning apps. This need could not be

addressed as part of the 2-stage PD (training and enactment). In particular, our teachers' needs and refocusing concerns were related to a set of current obstacles reported in the literature such as that embodied digital apps are usually proprietary and inaccessible as: (a) are mostly developed for research purposes, (b) are often based on expensive and technology-demanding installations (e.g. virtual/mixed reality rooms) and (c) are usually unlinked from the educational curriculum (Ioannou et al., 2019; Karakostas et al., 2017). These concerns imply a set of future directions, beyond teachers' professional development, that should be taken into account in order for technology-enhanced learning technology, or other innovations in educational technology and pedagogy, to enter our schools and nourish education.

6.1 Limitations and Future Research

Even though the findings of this study contribute to a better understanding of teachers' concerns in relation to technology-enhanced embodied digital learning as well as the impact of professional development on teachers' concerns, some limitations of this work are also important to note. First, the teachers sample participating in the study was relatively small. While this sample is deemed appropriate, given the exploratory nature of this study, future studies should aim for a larger sample which would allow generalizability of our findings. Second, this study was exclusively relied on the SoC questionnaire as a self-reported and retrospective measure which may be regarded as a limitation. Future studies could also use in-situ and more objective measurements (e.g. audio-recording or videotaping teachers' interactions during the PD programme) to investigate how the teachers' concerns unfold in real-time. Finally, our findings are most relevant to the PD programme of

the [European project] which was based on a two-phased model of PD. However, this is only one model of PD. Future studies could focus on different PD models and their impact on teachers' concerns as well as in supporting them to adopt innovative technologies and pedagogies.

6.2 Conclusions and Implications

The present study provided empirical evidence of teachers' concerns when adopting technology-enhanced embodied learning. At the same time, the study elaborated on a PD programme which had a significant impact on the mitigation of these concerns. By the end of the PD programme teachers shifted to only some high-level concerns, which are essential for the scalability and sustainability of technology-enhanced embodied learning. Overall, the CBAM model served as an effective system for tracing teachers' concerns and guiding our PD programme in supporting teachers to adopt technology-enhanced embodied learning. The use of the CBAM model as well as the rich description of our PD programme of the study might inform future efforts in this area. Given the emerging influence and the novelty of technology-enhanced embodied learning, taking into account and addressing teachers' concerns lays the groundwork for the successful adoption of this innovation in our educational systems.

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