DOI: 10.4025/jphyseduc.v36i1.3627

Original Article

EMPOWERING PE TEACHERS IN THE DIGITAL AGE: A PRETEST-POSTTEST STUDY OF THE EDUTECHPJ™ MODULE

CAPACITANDO PROFESSORES DE EDUCAÇÃO FÍSICA NA ERA DIGITAL: UM ESTUDO PRÉ-PÓS-TESTE DO MÓDULO EDUTECHPJ™

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RESUMO

A integração da tecnologia digital na educação é essencial para melhorar a eficácia do ensino e os resultados da aprendizagem. Contudo, os professores de Educação Física (PETs) muitas vezes lutam para incorporar essas tecnologias em suas estratégias de ensino e responsabilidades profissionais. Este estudo investiga a eficácia do módulo EduTechPJ™, concebido para melhorar as competências digitais dos PETs do ensino secundário. Participaram da formação 38 PETs, que visa dotá-los das competências necessárias para integrar a tecnologia digital nas suas práticas pedagógicas e administrativas. Utilizando um modelo pré-teste-pós-teste, as competências digitais foram avaliadas antes e depois da formação. Baseado na Teoria do Conectivismo, na Teoria da Competência Boyatzis e no Quadro Europeu de Competência Digital para Educadores (DigCompEdu), o módulo adota uma abordagem holística para o desenvolvimento de competências digitais. Os resultados mostraram uma melhoria significativa nas pontuações de competência digital, com médias aumentando de 73.1% no pré-teste para 92.7% no pós-teste ($p < 0.05$). Esta melhoria indica a eficácia do módulo no aprimoramento das competências digitais dos professores, que abrangem a integração da tecnologia nas funções docentes e administrativas. As conclusões destacam a necessidade de desenvolvimento profissional contínuo centrado na integração da tecnologia digital e no potencial de módulos personalizados como o EduTechPJ™ para colmatar a lacuna de competências digitais entre educadores, particularmente em Educação Física. Esta investigação contribui para o crescente corpo de literatura sobre competência digital na educação e fornece uma estrutura para futuras iniciativas de formação.

Palavras-chave: Treinamento digital. Integração de tecnologia digital. Competência digital dos professores. Desenvolvimento profissional de professores. Educação física.

ABSTRACT

The integration of digital technology in education is essential for enhancing teaching effectiveness and learning outcomes. However, Physical Education teachers (PETs) often struggle to incorporate these technologies into their teaching strategies and professional responsibilities. This study investigates the effectiveness of the EduTechPJ™ module, designed to improve the digital competencies of secondary school PETs. A total of 38 PETs participated in the training, aimed at equipping them with the skills necessary to integrate digital technology into their pedagogical and administrative practices. Using a pretest-posttest design, digital competencies were assessed before and after the training. Grounded in Connectivism Theory, Boyatzis Competency Theory, and the European Digital Competence Framework for Educators (DigCompEdu), the module adopts a holistic approach to developing digital skills. The results showed a significant improvement in digital competency scores, with means increasing from 73.1% in the pre-test to 92.7% in the post-test ($p < 0.05$). This improvement indicates the module's efficacy in enhancing teachers' digital competencies, which encompass the integration of technology into teaching and administrative functions. The findings highlight the need for continuous professional development focused on digital technology integration and the potential of tailored modules like EduTechPJ™ to bridge the digital competency gap among educators, particularly in Physical Education. This research contributes to the growing body of literature on digital competency in education and provides a framework for future training initiatives.

Keywords: Digital training. Integration of digital technology. Teachers' digital competency. Teachers' professional development. Physical education.

Introduction

The rapid advancement of digital technology has reshaped educational practices globally, highlighting the necessity for teachers to adapt and integrate these digital tools effectively. In the field of Physical Education (PE), the integration of technology presents unique challenges and opportunities. Varea et al[1] elaborated PE as practical and 'hands-on' subject in schools, where physical contact is common. Traditionally, PE has focused primarily on physical activity and sports, leading to less emphasis on digital competency in teaching and

learning compared to other subjects like mathematics or science, which have more readily integrated digital tools into their pedagogy[2]. However, as digital technology continues to transform educational practices, the need for PETs to incorporate these digital tools into both teaching and administrative functions is increasingly recognized.

In secondary education, the introduction of digital technology can play an essential role in engaging students who are often highly attuned to technology in other areas of their lives[3]. Digital technology can enhance PE instruction through innovative strategies, such as using fitness tracking apps, online platforms for monitoring progress, and digital assessments that allow for more personalized feedback[4]. Additionally, digital tools support the collection and analysis of student data, offering PE teachers new methods to assess performance and customize teaching approaches[5]. Furthermore, secondary school PETs often face greater administrative and assessment responsibilities than their primary counterparts, including managing student records, conducting assessments, and supporting extracurricular activities[6]. Therefore, digital technology can greatly enhance these administrative tasks, improving efficiency and allowing teachers to spend more time on instructional activities[7].

The need for targeted digital competency development in secondary PE is also emphasized in recent educational frameworks, such as the European Commission's: European Framework for the Digital Competence of Educators (DigCompEdu), which advocates for subject specific digital integration[8]. As education systems increasingly emphasize the importance of preparing students for a digital world, the role of all teachers including those in PE becomes crucial in developing well-rounded, digitally literate students[9]. In addition, Redecker[8] defined digital competency as the ability to use digital technologies confidently and critically in educational environment, is a key aspect of contemporary teaching standards. The DigCompEdu framework outlines progressive stages for educators' digital development, emphasizing the importance of continuous learning and adaptation. However, existing research reveals a gap in tailored digital competency training for PETs, who require specific guidance to integrate digital tools into the active, dynamic environment of PE[10].

By addressing this gap, the EduTechPJ^{TM} Module was designed to enhance the digital competencies of secondary school PETs. Grounded in Connectivism Theory, which emphasizes learning through digital networks[11] and Boyatzis' Competency Theory, which stresses skill development aligned with professional roles[12] the module provides a structured framework for PETs to acquire, apply, and sustain digital skills. By using this module through structured training, this study examines the effectiveness of the EduTechPJ^{TM} Module, using a pretest-posttest design, to assess its impact on the digital competencies of PETs.

Teachers' Digital Competency

Digital competency is an essential skill for teachers in the modern and technology-driven educational field. The DigCompEdu framework defines it as the confident, critical, and responsible use of digital technology to support and enhance learning, as well as for professional development[8]. Digital competency encompasses more than just basic technical skills, but it involves creating, evaluating, and sharing digital content, managing digital communication, and fostering digital literacy among students. In today's educational environment, teachers are expected to integrate digital tools effectively into teaching practices to improve learning outcomes.

Research consistently shows that teachers who develop strong digital competency are better positioned to adopt innovative teaching methods that engage students and enrich their learning experience[13]. However, many teachers still face challenges in developing the necessary digital skills, especially in subjects where technology has not traditionally played a central role, such as PE. In addition, research by Khaizer et al[14] indicated that secondary school teachers are

increasingly concerned about the current teaching and learning challenges brought about by the pandemic, and the need to optimize technology has become essential, as educators must fully equip themselves with online teaching skills to address potential future uncertainties.

Despite these shifts, many PE teachers are underprepared for the digital demands of contemporary education. Research by Martínez-Rico et al[15] found that PE teachers often lack adequate training in digital competencies and feel less confident in using technology compared to their peers in other subject areas. Therefore, continues professional development opportunities are crucial to closing this gap, allowing PE teachers to explore how digital tools can support instructional goals and enhance student engagement.

Several studies highlight the positive impact of continues professional development initiatives designed to enhance digital competency among PE teachers. For instance, a study by Wallace et al[16] found that when PE teachers participated in structured digital competency programs resulted in the ability to utilize technology in lessons significantly improved. Additionally, teachers who engaged with digital technology in their professional development reported increased motivation and confidence in using tech-based solutions to track student progress, promote fitness, and facilitate remote or hybrid learning environments. However, more research is needed to understand how different forms of professional development can be optimized to meet the specific needs of PE teachers.

Digital Competence Framework For Educators (DigCompEdu)

The DigCompEdu Framework was developed by the European Commission to guide educators in using digital technology effectively in their professional roles. The framework aims to help teachers integrate digital tools not only in their teaching practices but also in communication, assessment, and student empowerment. It highlights the importance of developing digital skills to meet the evolving needs of modern education, especially as technology becomes a central aspect of learning environments[8].

DigCompEdu is divided into six key areas of competence. These include professional engagement, which focuses on educators using digital technologies for collaboration and professional growth, digital resources which involve finding, creating, and sharing digital content, and teaching and learning where digital tools are used to improve teaching methods and student engagement. The framework also includes assessment which emphasizes the use of technology to track and evaluate student progress, and empowering learners which addresses adapting digital tools to support individual learning needs. Lastly, facilitating learners' digital competence focuses on helping students develop their own digital skills.

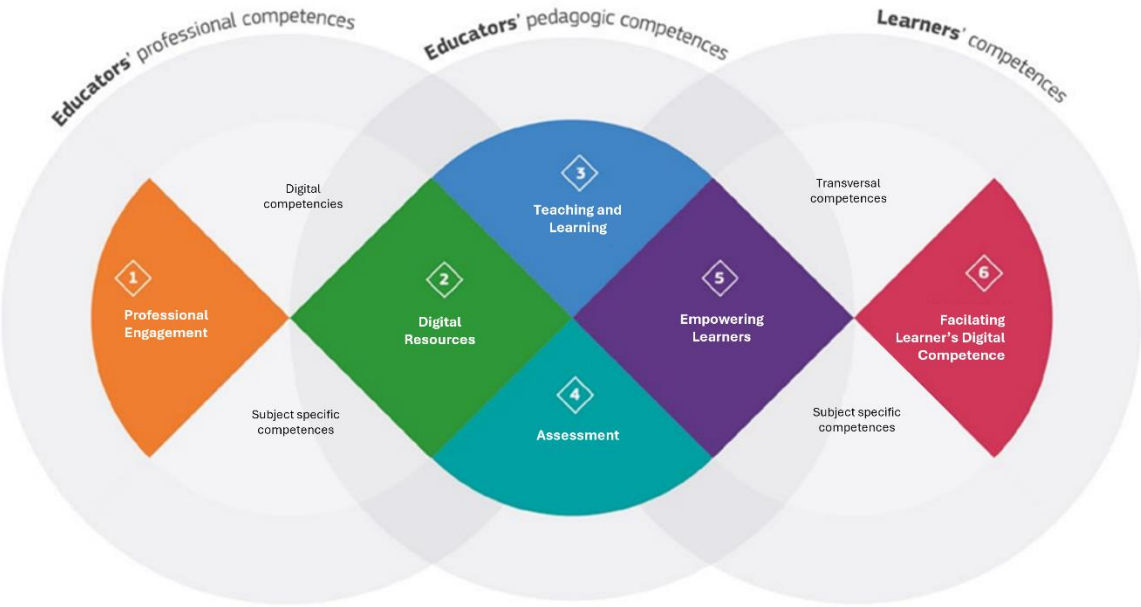

Figure 1. The DigCompEdu Framework
Source: Redecker[8]

The framework also categorizes teachers into six proficiency levels, ranging from A1 (Newcomer) where teachers are beginning to explore digital tools to C2 (Pioneer) where educators lead in creating innovative, technology-enhanced learning environments. At the basic levels (A1 and A2), educators are starting to use digital resources and platforms, while at higher levels (B1 to C2), they are expected to integrate technology more deeply, creating interactive, learner-centered environments, and even mentoring peers in the use of digital technologies[17]. This progressive structure supports educators' ongoing development as they enhance their digital skills to meet the demands of modern education.

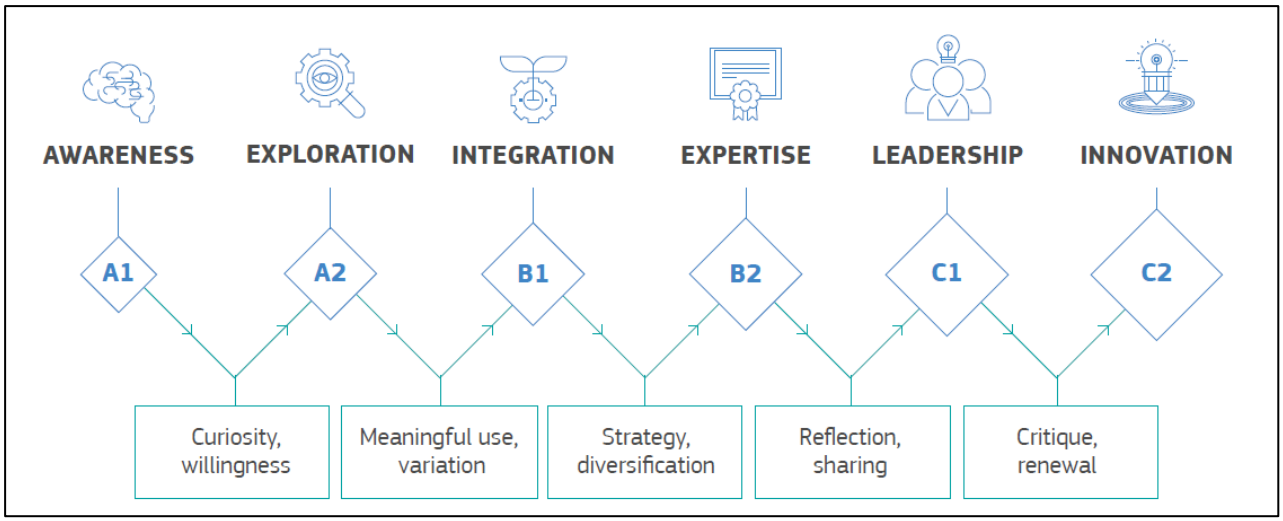

Figure 2. The Level of Digital Competence
Source: Redecker[8]

Methods

Sample

For this study, the participants were 39 secondary school PETs (n = 39) from various regions in Selangor, Malaysia who were selected through purposive sampling. This sampling method was chosen to ensure the inclusion of PETs with varying levels of prior digital competency, allowing for a comprehensive evaluation of the module's effectiveness across a diverse range of digital skill levels. The EduTechPJ™ Module used in this training was specifically designed to enhance the digital competencies of PETs. The training consisted of both theoretical and practical components, delivered within 4 days and totaling 32 hours of instruction.

Procedures

Data were collected using a structured questionnaire adapted from the SelfieforTeachers instrument, which evaluates digital competencies in teaching and professional practices. The basis of this instrument is the DigCompEdu framework that explained the digital competence proficiency level. The questionnaire consisted of 32 items, divided into six main domains: (1) professional engagement, (2) digital resources, (3) teaching and learning, (4) assessment, (5) empowering learners, and (6) facilitating learners' digital competence. Each item was scored using six level proficiency scale. The six level of teachers' digital competence started with newcomer (A1), explorer (A2), integrator (B1), expert (B2), leader (C1) dan pioneer (C2). The scoring of the questionnaires represents the teachers' level of digital competencies.

Table 1. Level of teachers' digital competence

Level	Digital Competence	Scores	Percentage (%)
A1	Newcomer	Up to 32/192	Up to 17
A2	Explorer	33-64/192	18-33
B1	Integrator	65-96/192	34-50
B2	Expert	97-128/192	51-67
C1	Leader	129-160/192	68-83
C2	Pioneer	161-192/192	84-100

Source: Redecker[8]

Furthermore, the adapted questionnaire demonstrated high internal reliability, with a Cronbach's alpha of 0.92. Pretest data were collected before the training started, while posttest data were gathered following five months after the completion of the module to verify its level of significance. In addition, a series of demographic questions were included in the questionnaire, covering sex, age, years of service as well as the level of education of the participants. The participants then completed the online questionnaires by using Google Form platform.

Statistical analysis

Descriptive and inferential statistics were used to analyze the gathered data. First, descriptive statistics, including means, standard deviations, and frequencies, were calculated to summarize the participants' digital competency scores before and after the training using SPSS version 29 software. Then, to determine the significance of changes in digital competency, a paired sample t-test was conducted, comparing pretest and posttest scores. The threshold for statistical significance was set at $p < 0.05$.

Results

The result of the study is demonstrated based on the objectives and research questions. The aim of this study was to investigate the effectiveness of the EduTechPJ^{TM} module, designed to improve the digital competencies of secondary school PETs. The effectiveness of the module is being tied to the positive significance of the teachers' digital competence after using this module. The delivery of the EduTechPJ^{TM} Module was conducted over a structured period of four days, utilizing a blended learning approach that combined both synchronous (live online sessions) and asynchronous (face to face learning) elements. The EduTechPJ^{TM} Module was fully implemented throughout the training, with all activities and assessments successfully completed. The demographic profile of the participants, who are PETs, is outlined below.

Table 2. Participants' demographic profile

Participants' background	Item	Frequency (f)	Percentage (%)
Gender	Male	17	44.7
	Female	21	55.3
Age	20-30 years	9	23.7
	31-40 years	16	42.1
	41-50 years	10	26.3
	51-60 years	3	7.9
Location of school	City	29	76.3
	Rural	9	23.7
Experience of teaching	Below than 5 years	15	39.5
	6-10 years	10	26.3
	11-15 years	6	15.8
	16-20 years	5	13.2
	21-25 years	1	2.6
	26 and above	1	2.6
Education qualification	Degree	31	81.6
	Master's degree	7	18.4
	Doctor of Philosophy	0	0

Source: Authors

As can be seen in the Table 2, of the 38 participants surveyed, 17 (44.7%) were male and 21 (55.3%) were female. Having 23.7% (f=9) between 20-30 years, 42.1% (f=16) between 31-40 years, 26.3% (f=10) between 41-50 years) and 7.9% (f=3) between 51-60 years. From all the participants, 29 (76.3%) teaching in the city while 9 (23.7%) teaching in the rural area. Regarding the years of teaching experience they had as teachers, 39.5% (f=15) below than 5 years, 26.3% (f=10) between 6-10 years, 15.8% (f=6) between 11-15 years, 13.2% (f=5) 16-20 years, 2.6% (f=1) 21-25 years and 2.6% (f=1) 26 and above years. Of these, 81.6% (f=31) had a degree and 18.4% (f=7) a master's degree.

Table 3. The analysis of pretest and posttest scores after the training using EduTechPJ™ Module

Areas	N		Mean Score		Std Deviation		Total by Area (%)		Total Overall		Digital Competency Scales	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Professional engagement	38	38	40.74	50.08	5.28	3.72	75.4	92.7			C1	C2
Digital resources	38	38	21.97	27.82	3.46	2.23	73.2	92.7			C1	C2
Teaching and learning	38	38	22.39	27.82	3.58	2.04	74.6	92.7			C1	C2
Assessment	38	38	13.24	16.79	2.21	1.32	73.6	93.3	73.1	92.7	C1	C2
Empowering learners	38	38	17.26	22.21	2.83	1.83	71.9	92.5			C1	C2
Facilitating learners' digital competence	38	38	25.05	33.13	5.03	2.70	69.6	92.0			C1	C2

Source: Authors

In the study, a comprehensive analysis of pretest and posttest scores following the training using the EduTechPJ™ module was conducted. The results are presented across six areas of digital competency: i) professional engagement; ii) digital resources; iii) teaching and learning; iv) assessment; v) empowering learners; and vi) facilitating learners' digital competence. The findings revealed substantial improvements in all areas post-training, with a marked increase in mean scores for each competency areas. The results clearly demonstrate the significant improvements in digital competencies among PETs after completing the EduTechPJ™ Module in the training, which is in line with recent literature on the importance of digital upskilling in education. Across all six areas that included of professional engagement, digital resources, teaching and learning, assessment, empowering learners and facilitating learners' digital competence teachers showed substantial advancements, which mirrors the growing need for teachers to develop higher levels of digital competency to meet the demands of 21st-century education[18].

In specific, the mean score in the professional engagement area increased from 40.74 in the pre-test to 50.08 in the post-test, accompanied by a decrease in standard deviation from 5.28 to 3.72, indicating not only improved competency but also a more consistent performance across participants. This area saw an overall percentage increase from 75.4% to 92.7%, demonstrating the module's effectiveness in enhancing teachers' capacity to engage with digital tools for professional growth and collaboration, moving them from C1 (intermediate) to C2 (advanced) on the digital competency scale.

Besides, the mean score of digital resources area rose from 21.97 to 27.82, with a corresponding reduction in standard deviation from 3.46 to 2.23, indicating that teachers became more adept at sourcing, managing, and utilizing digital materials in their educational practices. This area also showed an increase in the overall competency percentage from 73.2% to 92.7%, further highlighting the module's impact. In addition, it also highlights the module's success in equipping teachers with practical skills to enhance their digital resource management.

Similarly, for teaching and learning, the mean score increased significantly from 22.39 to 27.82, with a standard deviation reduction from 3.58 to 2.04, showing a greater consistency in the participants' ability to integrate digital technologies into instructional practices. This

area's overall percentage rose from 74.6% to 92.7%, again indicating an improvement from C1 to C2 in digital competency.

In terms of assessment, a critical component of teaching, the mean score improved from 13.24 to 16.79, with the standard deviation reducing from 2.21 to 1.32. The rise in percentage from 73.6% to 93.3% reflects teachers' enhanced capability in using digital tools for evaluating and assessing student performance.

The empowering learners area also saw a meaningful improvement, with the mean score rising from 17.26 to 22.21, and the overall percentage increasing from 71.9% to 92.5%, showing that teachers gained proficiency in using digital methods to foster learner autonomy and digital skills.

Finally, in facilitating learners' digital competence area, the mean score improved from 25.05 to 33.13, with the standard deviation decreasing from 5.03 to 2.70, indicating a notable increase in the teachers' ability to support and guide their students' development of digital competencies. The substantial percentage improvement from 69.6% to 92.0% further confirms the success of the EduTechPJ™ Module in this area. In addition, this competence reflects the broader objective of the DigCompEdu framework, which aims to equip teachers with the skills necessary to develop their students' digital literacy[8].

Discussion

In the domain of professional engagement, the transition of PETs from intermediate (C1) to advanced (C2) level on the digital competency scale demonstrates a significant advancement in their ability to leverage digital tools for professional development and collaborative practices. The findings were aligned with current literature, highlighting the crucial role of targeted continues professional development programs in advancing teachers' digital competencies[19,20].

This improvement in professional digital engagement reflects the module's success in addressing a fundamental aspect of modern teaching practice, particularly in the PE context where digital integration has traditionally been less emphasized. The substantial enhancement in teachers' digital resource management competency further illustrates their improved ability to select, create, and share digital content effectively, representing a crucial evolution in contemporary PE instructional methods.

The module's impact on teaching and learning practices demonstrates particular significance in the PE context, aligning with Attri's [21] research on digital technology integration in pedagogy for improved student engagement and learning outcomes. As Kimmons et al[22] emphasize, this advancement is crucial in the modern educational landscape, where digital integration has become essential for both classroom management and instructional delivery, even in traditionally physical-focused subjects. The marked improvement in assessment capabilities shows PETs' enhanced proficiency in implementing digital evaluation tools, supporting Ramadhan and Inayati's[23] findings on the importance of digital assessment in personalized learning and formative evaluation approaches within physical education settings. The empowerment of learners through digital platforms emerged as a particularly noteworthy achievement of the module, supporting Haleem et al[24] findings regarding the relationship between digital technology integration and enhanced student autonomy and motivation in physical education contexts. The improvement in facilitating learners' digital competence aligns strategically with the core objectives of the DigCompEdu framework[8], demonstrating how PE teachers can effectively integrate digital literacy into movement-based education. As highlighted by Alipkhanova et al[25], this capability is increasingly crucial in modern education, and the module's success in this area demonstrates its effectiveness in preparing PETs to guide students through blended physical and digital learning environments.

The implementation of the EduTechPJ™ Module has demonstrated comprehensive effectiveness in enhancing digital competencies among PETs across all six areas of the DigCompEdu framework, marking a significant advancement in PE teacher professional development. These improvements indicate the module's success in addressing the specific needs of PE teachers in the digital age while maintaining the unique aspects of physical education instruction. The consistent advancement across all competency areas suggests that the module provides a well-balanced approach to digital professional development in PE. This successful integration of digital competencies represents a significant contribution to the field, demonstrating how digital transformation can be effectively achieved within PE teaching practices while preserving the essential hands-on nature of PE.

Conclusion

The main objective of this study was to assess the effectiveness of the EduTechPJ™ Module in enhancing the digital competencies of secondary school PETs. The findings reveal significant improvements across six key competency areas in DigCompEdu Framework, with the overall digital competency increasing from 72.5% to 92.7% post-training. Specifically, teachers showed notable advances in professional engagement, the use of digital resources, and the integration of digital tools for teaching, learning, and assessment. Our findings align with those of[26] who reported similar improvements in digital competencies among teachers following targeted professional development. However, our study extends these findings to the specific context of PE, demonstrating the adaptability of digital competency training across different subject areas.

The significant improvements observed across all digital competency areas suggest that structured, subject-specific digital training programs like the EduTechPJ™ module could be valuable additions to ongoing professional development initiatives for Physical Education teachers. While this study provides valuable insights into the effectiveness of the EduTechPJ™ module, it is important to acknowledge its limitations. The relatively small sample size and the lack of a control group limit the generalizability of our findings, future research should consider larger-scale implementations and include control groups to further validate the effectiveness of the module. Future research could address these limitations by employing larger, more diverse samples and incorporating control groups. This would allow for a more comprehensive understanding of the impact of digital competency training on teaching practices across various educational contexts. Future studies could explore the long-term impact of digital competency training on student learning outcomes in PE, as well as investigate the potential differences in digital competency development between novice and experienced teachers.

In conclusion, the EduTechPJ™ Module proved highly effective in fostering digital competencies, equipping teachers with essential skills for navigating the evolving technological landscape in education. These findings imply that structured digital competency training can play a critical role in professional development, promoting innovative teaching practices and enhancing educational outcomes. Moreover, this module is particularly valuable in subject areas where technology has traditionally been underutilized, such as PE.

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Editor: Carlos Herold Junior.
Received on Nov 11, 2024.
Accepted on Mar 26, 2024.

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