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Physical Culture and Sport. Studies and Research, 2025, 108, 71–83
https://doi.org/10.2478/pcssr-2025-0013

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Associations Between Technology Use, Knowledge and Inclusive Physical Education Teacher-Efficacy Among European Primary School Teachers

Authors' contribution:

A) conception and design of the study
B) acquisition of data
C) analysis and interpretation of data
D) manuscript preparation
E) obtaining funding

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Received:
Accepted:

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Abstract

Across many countries, an increasing number of schools include children with and without disabilities in the same environment, learning in the same class which can be challenging for primary school teachers when teaching physical education (PE). The purpose of this study was to investigate the use of technology for inclusive PE by primary school teachers in Northern European countries. A convenience sample of primary school teachers was asked to complete an online survey with measures on (technological pedagogical and content knowledge, PE version (TPACK-21-PE), inclusive PE teacher efficacy, and the use of technology for teaching. Mediation analyses were conducted to explore TPACK-21-PE on the association between technology use and teacher efficacy. Teachers in general (n = 119) and special education classes or schools (SECS; n = 90) responded to the survey, with the most common technologies including videos and integration into PE. Teachers in general schools reported more use of technology and had a higher TPACK-21-PE score than SECS teachers. Teacher efficacy was highest for students with intellectual disabilities and lowest with visual impairments and was highest among SECS teachers. TPACK-21-PE mediated teacher-efficacy for all three types of students, but negatively for TPK for students with physical disabilities. This study has highlighted the important role of building pedagogical competencies in teachers using technology in PE. More training is needed to build on this knowledge so that technology can enhance teachers' abilities, and thus the learning outcomes of students in their class, particularly for children with disabilities.

Keywords: technological pedagogical and content knowledge, adapted physical education, special education, in-service, special education needs

Introduction

The right to education for all is an ongoing process of inclusion, as enshrined in the Salamanca Statement (UNESCO, 1994) and specifically for physical education (PE) under Article 30 of the United Nations Convention on the Rights of Persons with Disabilities (United Nations, 2006). These documents emphasis the right to PE

for children with and without disabilities. Despite this, the enactment of inclusive PE varies vastly around the globe (Ng et al. 2023). The European Agency for Special and Inclusive Education has been collecting information since 2010 to highlight the landscape of inclusive education across Europe (Ramberg et al., 2018). Each country has a profile, which includes essential skills, knowledge, understanding, attitudes and values needed by teachers (European Agency for Development in Special Needs Education, 2012), and it should be no different for PE.

PE is implemented across diverse learning environments, including gymnasiums, stadiums, swimming pools, and other educational venues. It encompasses a broad spectrum of content, covering individual sports to team-based sports activities (Rocliffe et al., 2023). The outcomes of the PE program vary depending on the objectives and activities assigned within the school environment. For example, primary school PE classes often focus on improving movement skills, such as locomotor and object control skills, as well as creative components, such as dance and gymnastics (Kulinna, 2008). In addition to its physical benefits, PE can also help students develop social and cooperation skills, such as fair play, teamwork, and respect (Braksiek, 2022; Sigstad et al., 2022). Inclusive PE classes pose additional challenges for primary school teachers because they require knowledge and skills related to adapted physical education (APE). According to Winnick and Porretta (2022), APE is viewed as a subdiscipline of PE that provides safe, satisfying, and successful experiences for students with varying abilities. To put it another way, APE is essential to the inclusive PE framework because it makes sure that students with special education needs (SEN) have the support and training they need to engage fully in PE with their classmates.

In many countries across Europe, PE in primary school is taught by the regular classroom teacher instead of a specialized PE specialist (Jones and Green, 2017). This can mean that the amount of training and experience in PE is limited, let alone for the crossover between special education and PE. Since 2000, inclusive educational environments were stated in Lithuanian legislation, thus all primary school teachers need to have the capacity to organize inclusive lessons, including PE (Lithuania, 2000). Furthermore, in Finland, often general PE classes may include more than one student who requires individualized attention and differentiated teaching approaches (Ng et al., 2019). Yet, despite these figures and the need to build teacher competencies, many classroom teachers feel inadequately prepared to deliver inclusive PE. This is not surprising since few hours are dedicated to pre-service training in PE and inclusion (Fletcher and Mandigo, 2012).

For inclusion to work, general PE teachers have to consider how children with disabilities influence other students, the way special education is incorporated into PE, ideas for meeting the curriculum, cooperation with support staff working with children with disabilities, as well as the teachers' own continual professional development (Morley et al., 2021). PE teachers have raised concerns about their lack of confidence to teach children with and without disabilities or SEN in the same class (Block et al., 2013). In addition to the challenges to inclusive classroom teaching, whereby teachers 'provide instruction based on the student's individual need' (Zigmond, 1997: 379) and have awareness of different tier support needed for students (Zigmond et al., 2009), inclusive physical educators need to be aware of personal safety issues to support children with SEN (Healy et al., 2013). PE is a subject where students may be forced to work together in team sports, and some students may have difficulties with social interaction (Maher, 2018), thus good teaching practices include lesson plans with several contingencies ready. There are also many institutional barriers that slow down progress towards inclusive societies. Yet, one area that can be changed is the sense of self-efficacy amongst teachers (Nowland and Haegele, 2023).

Teaching inclusive PE has some unique dimensions from regular special education teaching (Overton et al., 2017; Petrie et al., 2018). For example, students with severe visual impairments require frequent support in inclusive PE, whereas the support needed is less intensive when students use computers or books in Braille. These differences present challenges for PE teachers to plan and provide safe and meaningful PE content for students with SENs in an inclusive setting. A teacher's self-efficacy toward the inclusion of children with disabilities may be specific to the disability type or curriculum content, such as teaching a sport skill, performing fitness training or assessment, or playing a sport game (Block et al., 2013). Therefore, teachers need to know what teaching methods and supporting instruments will foster a learning environment that enables every student to participate at their highest capacity. This might be achieved by using technologies that provide students with options of activities according to their specific needs and individualized education plan in PE.

Technology use and Teacher-Efficacy

Self-efficacy is a construct that refers to an individual's belief in his or her capability to develop professional competence to accomplish specific or related tasks (Bandura, 1977). An example of this can include, teaching heterogeneous groups of students with SEN in inclusive PE (Block et al., 2013). Teachers with higher self-efficacy tend to have the ability to make adjustments to their teaching with students with diverse needs (Dixon et al., 2014), particularly in aspects such as classroom management

and instructional strategies (Tschannen-Moran and Hoy, 2007). Typically, teachers with more experience tend to express higher self-efficacy levels (Gale et al., 2021), yet the role of technology on these levels of self-efficacy in inclusive PE is less known.

Following the COVID-19 restrictions in schools, more technology has been used in primary schools than ever before (Centeio et al., 2021). Building upon the efforts of the European Commission, the new Action Plan outlines a comprehensive approach to foster high-quality and inclusive digital education and training during next programming period between 2021 and 2027 (European Commission, 2020). Following these initiatives, several EU countries have developed policy and strategic guidelines to increase the digital literacy education in school programmes (OECD, 2023). For example, in Lithuania, primary school age children in PE should learn to use smart devices and technologies to generate simple movement reproduction as shown on the screen. As students move onto higher grades, smart technologies are often employed to facilitate self-assessment of physical activity, enhance movement skills, and deepen comprehension of observed parameters and their significance. In Poland, teachers are encouraged to use information and communication technologies for the lesson preparation, teaching, and assessment in PE (Rogacka, 2019).

Although COVID-19 may have been seen as a way to make teachers think more about the use of technology, the research into technology and PE has been around for quite some time (Juniu, 2011). Originating from Shulman's (1986) concept that pedagogical content knowledge (PCK) comprises of separate, yet overlapping aspects for teachers, technology was added to form the Technological Pedagogical and Content Knowledge (TPACK) framework (Mishra and Koehler, 2006). TPACK consists of seven components made up of individual and interactions of technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK). The published literature on TPACK has grown from 18 papers in 2011 to 129 in 2020 (Lee et al., 2022), yet the use among PE teachers is sporadic. Lee and colleagues (2020) argued that PE teacher education practices should be urgently updated to reflect on the use of technology in the lessons. Technology in PE can range widely, which align with future generation use, such as video modelling, feedback and social media (Koekoek and Van Hilvoorde, 2018). Concerning the latter, teachers may use social media as a form of technology for their own person use and self-development (McNamara et al., 2022), it remains unclear how their use of technology can be used to improve their teaching practices and the outcomes of their students.

It goes without saying, to increase knowledge in technology, individuals need to use technology in their teaching as a 21st century skill (Cengiz, 2015). As with digitalisation, some teachers are confident to use it, whereas others report challenges to use technology for teaching (Valtonen et al., 2020), and it is likely to be no different in the PE setting. Teachers who work with children with SEN have also reported the additional burden to use technology on top of the usual inclusive pedagogical aspects such as differentiation, enhanced motivation, and cooperative teaching (Anderson and Putman, 2020). Hence, it is likely to have an effect on the teachers believes in their teaching abilities, especially when it comes to PE. Given that self-efficacy to teach inclusive PE is a good predictor for student outcomes, and the emergence of technology for PE, we hypothesize that teachers' technological pedagogical and content knowledge in PE (TPACK-21-PE) would mediate the relationship between technology use and self-efficacy to teach children with disabilities in PE.

The purpose of this study was to investigate the use of technology by primary school teachers. Furthermore, we examined the structure of TPACK-21-PE and inclusive teacher-efficacy among primary school teachers, to then explore the mediating effect of the concept of TPACK-21-PE on the relationship between technology use and inclusive PE teacher self-efficacy of primary school teachers in European countries.

Method

Data Collection and Recruitment

Recruitment of teachers to the study was conducted between January and February 2023. Participants were general teachers and PE teachers, providing PE classes in the first three grades of primary schools, originally recruited from Latvia, Lithuania, Finland, and Poland. Subsequently, a call was opened for teachers in the English-speaking countries, namely, UK and Ireland, to boost recruitment numbers. In order to have a sufficiently powered study with mediation analyses in mind, we used the simulations from Fritz and MacKinnon (Fritz and MacKinnon, 2007). We expected a large effect (=.59) between technology use and TPACK-21-PE, and a halfway small to medium effect (=.26) between TPACK-21-PE and SE-PETE-DP. With statistical power of 0.8, a minimum sample size would be 115 participations. Hence, we targeted recruitment of 200 teachers, through a convenience sample, in the case there would be incomplete data.

To be included, participants had to be teachers at primary schools. The teachers were contacted in each of the countries through national teaching associations and posts on social media. Participants were informed of the objective of the investigation and a universal link to an online survey with possible language selection. Participants actively gave their informed consent to take part

in the study voluntarily. Due to the non-invasive nature of the study with adult participants through surveys, this type of data collection did not require institutional ethical approval from the lead author's ethics committee. Nevertheless, the study was conducted in compliance with the Declaration of Helsinki and the participants were assured their data was confidential and anonymized during data analyses. The study was registered on OSF (https://doi.org/10.17605/OSF.IO/72THZ) on 14th March 2023.

Survey Development and Translation

The survey, including background variables, the adapted versions of the Self-Efficacy Scale for Physical Education Teacher Education Majors towards Children with Disabilities (SE-PETE-D; Block et al., 2013) and the Technological, Pedagogical and Content Knowledge for 21st century teachers (TPACK-21; Valtonen et al., 2017) scales. Items from the SE-PETE-D have been reported as valid for teachers (Block et al., 2013) and were modified to align more closely with activities suitable for primary school students. The SE-PETE-D questionnaire begins with a vignette for each of the three disability groups that were covered, namely intellectual disability (ID), physical disability (PD), and visual impairment (VI). The researchers reviewed the vignette and questions before adapting the text to aligned more with primary school activities. For example, in SE-PETE-D, the questions were based on teaching a 9th grade fitness testing class and a team sport unit. Whereas, in questions of the primary version of SE-PETE-DP, the same question was based on teaching 'a new game, like "tag" that uses different types of fundamental movement skills, (e.g. jumping, running, catching, coordination, speed, etc) to your class of 30 students that includes Noah', where Noah was the name of the personified individual from the vignette.

The original items from the TPACK-21 were validated (Valtonen et al., 2017) and modified from knowledge in 'natural sciences' to 'PE for students with SEN' to produce the TPACK-21-PE (Ng et al., 2021). Using the back-translation technique described by Brislin (1970) each the survey was translated from English to Finnish, Latvian, Lithuanian, and Polish. In addition, for each language, adapted physical activity experts were asked to review and give feedback for clarity, conciseness, and terminological precision. Where necessary, modifications were made before administering the online survey.

Measures

Background variables

The background variables in the questionnaire were adapted from the version used by Ng et al. (2021). Items included demographic data such as respondents' gender, age, and the type of school they work in (i.e. general school, special school classes in general school in the same or separate building, or special education schools).

TPACK 21st Century Physical Education

The TPACK-21 scale developed and validated by Valtonen et al. (2017) to determine knowledge of teachers' 21st century skills. The TPACK-21 framework consists of three different areas of knowledge: technology (TK; 1), pedagogy (PK; 2), and content (CK; 3), and the combination of these: technological pedagogical (TPK; 4), pedagogical content (PCK; 5), technological content (TCK; 6), and technological, pedagogical, and content (TPACK; 7). Each item has a six-point response scale ranging from '1′ representing 'I need a lot of additional knowledge about the topic' to '6′ representing 'I have strong knowledge about the topic' (Valtonen et al., 2017). Where the context was necessary, items were converted to inclusive PE (TPACK-21-PE).

Teachers' Self-Efficacy Toward the Inclusion of Students with Disabilities in PE

The validated English version of the Block et al. (2013) Self-Efficacy Scale for Physical Education Teacher Education Majors towards Children with Disabilities (SE-PETE-D) was modified to address the professional context (PE teachers or general teachers) and educational stage where the teaching is performed (first grades of primary school). The narration as vignettes, preceding each subscale. In the vignettes, there was a narrative about the situations that students with ID, namely Noah, PD with the name Ashton, or VI whose name was Sofia, have during PE classes was adapted to the program content of PE classes in the first grades of primary school. This was discussed and agreed upon by the authors to ensure cross-cultural acceptability for primary level students. Consistently, the subscale items covering the dimension of self-efficacy (i.e. the instruction to peers, specific adaptations, staying on task, and safety) were limited to 6 items per subscale and focused on games and sports, instead of sport skills and fitness testing to create a primary teacher specific scale of SE-PETE-DP. All responses were rated on a five-point confidence Likert scale, ranging from 1 (no confidence) to 5 (complete confidence). Higher scores indicate a higher perception of the teacher's self-efficacy to include students with ID, PD, or VI in PE classes.

Statistical Analyses

Teachers who worked in special education classes or schools (SECS) were grouped together and were compared against teachers who taught in the general school setting. Differences were tested using Chi-square test of independence for category variables (gender, age, level of experience, prior training, use of technologies). T-tests

were used to examine differences between school settings in TPACK-21-PE and self-efficacy scales. Cohen's d was used for reporting the effect size of the differences.

The SE-PETE-DP scale and TPACK-21-PE items were tested by a principal component analyse using SPSS 27.0. Both principal component analyses used the Oblimin rotation to examine the best fit factors. Items that fit with the factors were then combined into a sum score for each factor, and Cronbach alpha was used to determine how well items in the scale performed. A correlation matrix was used between the three groups of SE-PETE-DP and the dimensions of TPACK-21-PE using Pearson's correlation coefficient.

To test the mediating effect of TPACK-21-PE on the relationship between technology use and self-efficacy, the maximum likelihood estimator with 10,000 bootstrap replications was used in a mediation analysis conducted in JASP 0.17.1. The limit of 10,000 bootstraps was recommended by Hayes (2013) for maximum likelihood estimates in mediation analyses, which could also compensate for potential misinterpretations for data that violates assumptions of normality. The independent variable was the sum score of teachers' reported often use of technologies. The dependent variables were the self-efficacy scores from the three groups of students; (1) ID, (2) PD, and (3) VI. To reduce the number of mediators, only the interactions of the TPACK dimensions were included, such that TPACK, TCK, TPK, and PCK mediated the relationship between technology use and self-efficacy. The mediation analyses were controlled by school type (general vs SECS).

Results

A total of 209 teachers completed the online survey from Latvia (n = 42), Lithuania (n = 88), Poland (n = 67) and from other European countries (i.e. Ireland, Finland, United Kingdom, n = 12). Most teachers were females (90%) and worked in general schools (57%). A third of the teachers (33%) worked in general schools with special education classes in the same building. More SECS teachers reported moderate or a lot of experience in teaching students with cognitive ($p < .001$), physical ($p < .001$), or visual ($p = .01$) impairments than general schoolteachers. Details about the age and prior training are reported in Table 1.

Table 1. Sample demographics by teaching environment

	General n=119	SECS n=90	Total n=209	X2-test p
Gender (%)				0.066
Male	6.7	14.4	10.0	
Female	93.3	85.6	90.0	
Age (%)				0.164
18-29	5.9	5.6	5.7	
30-39	11.8	22.2	16.3	
40-49	29.4	34.4	31.6	
50-59	43.7	32.2	38.8	
60-69	9.2	5.6	7.7	
Moderate or substantial teaching experience of students with disabilities (%)				
Intellectual	56.3	80.0	66.5	<.001
Physical	26.9	56.7	39.7	<.001
Visual	13.4	27.8	19.6	0.01
Prior training (%)				
Experience with teaching SEN pupils	38.7	38.9	38.8	0.973
Complete APA/APE coursework	23.5	22.2	23.0	0.824
Attended optional APA/APE training	50.4	45.6	48.3	0.486

Frequency of Technology Use

Of the different technological use, videos were used the most (33%), followed by technology integration in PE (29%) and digital assessments (27%). More general schoolteachers reported always or often use of technology integration in PE ($p < .001$), interactive websites ($p = .004$), and apps ($p = .019$) than SECS teachers. Over half the

respondents reported they never use podcasts (54%) or large-scale interactive platforms (51%).

Structure of TPACK

The seven dimensions of TPACK-21-PE instrument all had excellent alpha values (Table 3). Across the teachers, PK had the highest score (mean = 4.4, SD = 0.95), whereas TCK had the lowest (mean = 3.1, SD = 1.18). General education teachers had higher scores in PK ($p < .001$), TK ($p = .01$), TPK ($p < .001$), and TPACK ($p = .02$) than SECS teachers. All statistically significant differences were considered to have small effect sizes with ranges of $d = 0.37$ to $d = 0.42$.

Structure of Self-Efficacy

The structure of SE-PETE-DP for teaching inclusive PE was very good, with high Cronbach alphas, as reported in Table 4. Mean levels were the lowest among the items related to teaching children with VI (Sofia), followed by ID (Noah) and highest among teaching children with PD (Ashton).

Teachers in SECS scored higher than general school-teachers in the self-efficacy scores in teaching students with ID, (mean = 3.6 vs. 3.3, $p = .005$, $d = .38$) and PD (mean = 3.3 vs. 3.0, $p = .045$, $d = .28$). There were no statistically significant differences between the teachers for self-efficacy in teaching students with VI ($p = .354$, $d = .13$).

Table 2. Proportion of often or always use of technology use in PE teaching by school environments

	General (%) n=119	SECS (%) n=90	Total (%) N=209	X2-test p
Videos (i.e., exercise, dance)	37.0	26.7	32.5	.115
Technology integration in PE (screens, projectors, etc)	40.3	14.4	29.2	<.001
Digital assessment tools	34.5	17.8	27.3	.007
Digital teaching tips	22.7	16.7	20.1	.282
Interactive websites (e.g., Kahoot)	24.4	8.9	17.7	.004
Virtual reality	16.0	10.0	13.4	.210
Apps (i.e., Geocatch, etc.)	14.3	4.4	10.0	.019
Large scale interactive platforms (e.g., iWall)	10.1	6.7	8.6	.383
Podcasts	9.2	5.6	7.7	.321

Note: PE -physical education; SECS – special education classes and schools

Table 3. Structure of TPACK-21-PE among primary school teachers with differences in mean scores by school environments

			General		SECS		Total		T-test	Cohen's
	Items	Alpha	Mean	SD	Mean	SD	Mean	SD	p	d
Pedagogical knowledge	10	0.938	4.51	0.092	4.11	0.95	4.34	0.95	<.001	0.42
Content knowledge	4	0.901	3.32	1.20	3.37	1.04	3.34	1.13	.072	0.05
Technological knowledge	4	0.893	4.09	1.09	3.70	1.09	3.92	1.11	.01	0.36
Pedagogical and content knowledge	9	0.966	3.42	1.12	3.82	1.05	3.60	1.11	<.001	0.37
Technological and content knowledge	4	0.922	3.11	0.120	3.04	1.16	3.08	1.18	.68	0.06
Technological pedagogical knowledge	10	0.974	3.86	1.10	3.45	1.14	3.68	1.14	<.001	0.37
TPACK	7	0.980	3.61	1.21	3.23	1.12	3.45	1.18	.02	0.32

Note: SECS – special education classes and schools, TPACK – Technological Pedagogical and Content Knowledge

Mediation of TPACK Between Technology Use and Self-Efficacy

There were positive correlations between the factors of SE-PETE-DP and TPACK-21-PE (Figure 1). Of the factors, the correlations were generally the lowest between the single TPACK domains (i.e. PK, CK, and TK) with self-efficacy to teach each of the three disability groups. There were also weak correlations between TPK

Table 4. Factor loadings (with Oblimin rotation) of self-efficacy components and Cronbach alpha of self-efficacy to teach different disability types

Relative items	Physical (Ashton)	Intellectual (Noah)	Visual (Sofia)
Item 1	0.910	0.848	0.884
Item 2	0.940	0.860	0.904
Item 3	0.923	0.833	0.878
Item 4	0.907	0.906	0.857
Item 5	0.954	0.855	0.911
Item 6	0.940	0.886	0.924
alpha	0.933	0.950	0.968
mean	3.46	3.12	2.78
SD	.75	.93	1.08

with ID (r = .264, p < .001), PD (r = .184, p = .008), and VI (r = .242, p < .001). The strongest correlations were between PCK and teaching children with ID (r = .551, p < .001), PD (r = .568, p < .001), and VI (r = .437, p < .001).

The were no direct effects between technology use and self-efficacy for any of the disability groups (Table 5). That is to say, that more technology use was not associated with higher self-efficacy scores.

Table 5. Standardised regression coefficients (beta) with 95% confidence intervals from 10,000 bootstrapping samples of the mediation of TPACK components on the relationship between technology use and self-efficacy, after controlling for school environments

	Effect on ID r^2 – 0.33				**Effect on PD r^2 – .35**				**Effect on VI r^2 – .23**			
	Beta	**LCI**	**UCI**	**p**	**Beta**	**LCI**	**UCI**	**p**	**Beta**	**LCI**	**UCI**	**p**
Direct effect												
Tech – SE	0.00	-0.14	0.13	.99	0.11	-0.02	0.23	.12	0.08	-0.08	0.23	.31
Indirect												
Tech – PCK – SE	**0.20**	**0.11**	**0.30**	**< .001**	**0.22**	**0.12**	**0.32**	**< .001**	**0.16**	**0.06**	**0.25**	**.001**
Tech – TCK – SE	-0.04	-0.15	0.06	.41	-0.04	-0.14	0.06	.44	-0.07	-0.18	0.04	.23
Tech – TPK – SE	-0.00	-0.08	0.07	.90	**-0.08**	**-0.15**	**-0.00**	.04	-0.03	0.11	0.05	.42
Tech – TPACK – SE	**0.10**	**0.00**	**0.20**	**.04**	**0.12**	**0.02**	**0.22**	**.02**	**0.14**	**0.03**	**0.25**	**.01**
Total effect												
Tech – mediators – SE	**0.26**	**0.11**	**0.41**	**< .001**	**0.33**	**0.19**	**0.46**	**< .001**	**0.27**	**0.13**	**0.41**	**< .001**

Note: bold numbers are statistically significant. LCI – lower confidence interval; UCI – upper confidence interval; ID – intellectual disability; PD – physical disability, VI – visual impairment; Tech – technology use, PCK – pedagogical content lnowledge; TCK – technological content knowledge; TPK – technological pedagogical knowledge, TPACK – Technological Pedagogical and Content Knowledge; SE – self-efficacy

PCK and TPACK were statistically significant mediators for teaching all three types of students, with the standardised beta coefficients doubled for PCK (beta = 0.20, CI = 0.11-0.30, p < .001) to TPACK (beta = 0.10, CI = 0.00-0.20, p = .04) for teaching those with ID. PCK and TPACK were positive mediators, yet, TPK was negative (beta = -0.08, CI = -0.15 - -0.00, p = .04). Both PCK (beta = 0.16, CI = 0.06 – 0.25, p = .001) and TPACK (beta = 0.14, CI = 0.03 – 0.25, p = .01) were also significant mediators for teachers' self-efficacy to teach children with visual impairments, although effect was like each other. These mediation results can be interpreted as increases in technology use, with increased knowledge in pedagogical content knowledge and technology pedagogical and content knowledge was associated with increased levels of self-efficacy.

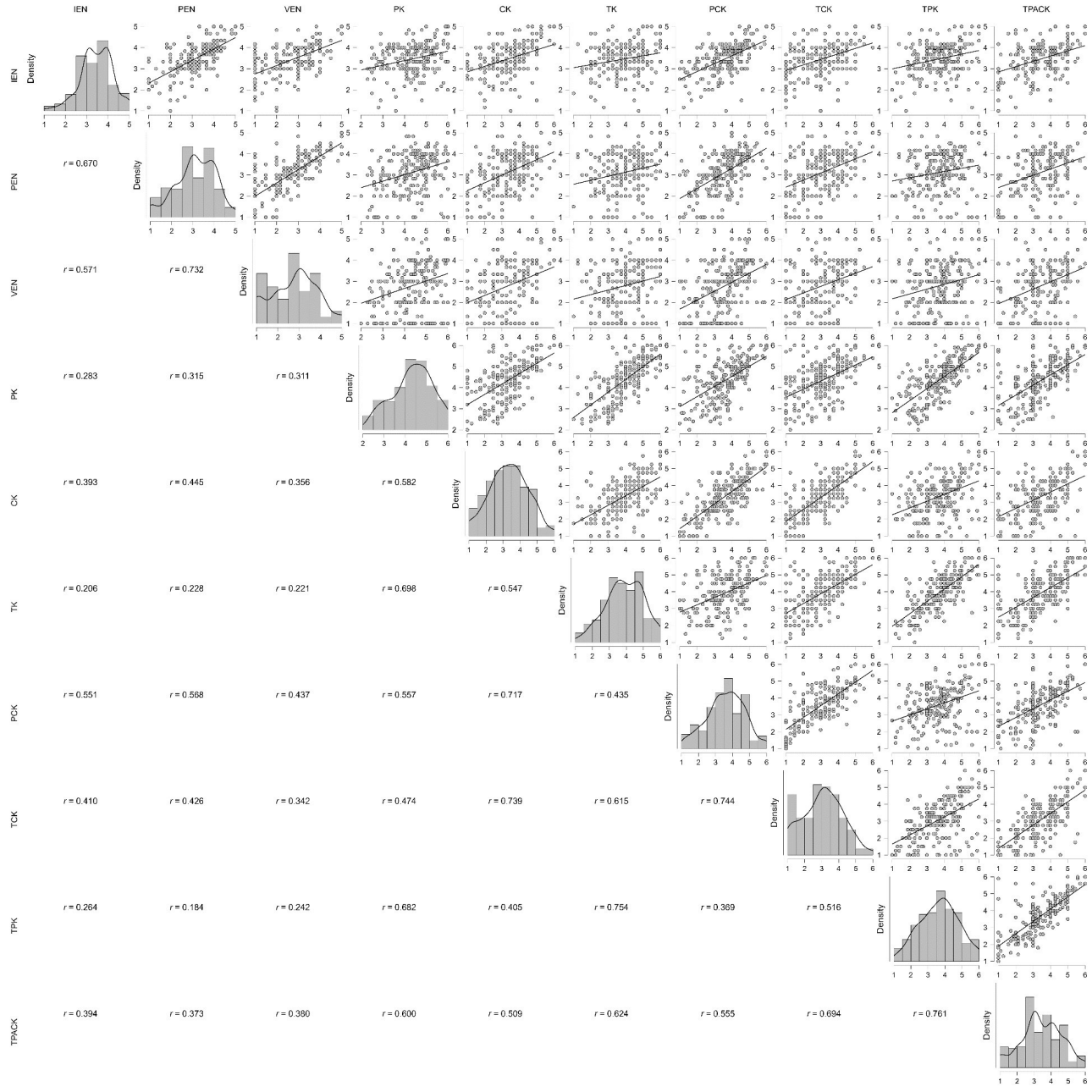

Figure 1. Pearson's correlations between SE-PETE-PD and TPACK-21-PE factors

Footnotes: ID – intellectual disabilities; PD – physical disabilities; VI – visual impairments; PK – pedagogical knowledge, CK – content knowledge, TK – technological knowledge, PCK – pedagogical content knowledge, TCK – technological content knowledge, TPK – technological pedagogical knowledge, TPACK – Technological Pedagogical and Content Knowledge;

Discussion

In this study, we examined the different types of technology use among primary school teachers in PE across Europe, and its relationship with teacher self-efficacy to teach in an inclusive environment. We also found the structure of the SE-PETE-DP and TPACK-21-PE instruments were acceptable to use among primary school teachers. In summary, general education schoolteachers had more technology use in PE and had higher PK, TK and TPACK scores, than those in SECS. Although, in terms of teaching children with disabilities in PE, the SECS teachers had higher self-efficacy than general schoolteachers. We also hypothesized TPACK would be a mediator in the relationship between technology use and self-efficacy. We found that the PCK and TPACK components of

the scale mediated the relationship between technology use and PE teacher efficacy when working with students with intellectual, physical, or visual disabilities, thus confirming our hypothesis. That is to say, the increase of technology use was associated with increased levels of PCK and TPACK, which in turn was associated with increased self-efficacy to teach children with disabilities. Although, it seems an obvious finding, it is interesting to show evidence of such semi-causal chain with use of the mediation model and justified the need of intersectional skills for teachers in 21st century.

The most common types of technology use among teachers for inclusive PE were use of videos, technology integration and digital assessments. The use of videos by at least a third of teachers is not surprising given the wide availability of videos available as teaching resources (UNESCO, 2017; UNESCO et al., 2015). Even before the availability of internet videos, resources for APE would often include videos to help pre- and in-service teachers. The emergence of broader social media channels has made it possible to share videos to teachers in APE groups or communities, as well as increased ways to teachers connect with each other to share experiences (McNamara et al., 2022; Murtagh et al., 2023). Videos can also be used for analysis and giving feedback to the students, particularly in skill development, tactical approaches, and instructional practices (Koekoek and Van Hilvoorde, 2018; Lee and Gao, 2020). Often, teachers' use of technology can be dependent on their acceptance to use it as part of their work, through their perceptions of use, behavioural intention and technology use (Scherer et al., 2019). Furthermore, primary school teachers often need to make a value judgement on the relevance, ease of use, and usefulness of technology, especially on the way it may influence students' motivation in class (Wijnen et al., 2023). As such, videos and digital assessments are deemed as easy to use technologies that can benefit the teacher's instruction and could be why they were the most used technologies.

Other technologies may carry the use of data and there could be concerns with data protection, privacy and access. This may be of more concern when it is about children with SEN. It has to be noted that in the school setting, education institutions and teachers have to ensure that they are legally compliant regarding data protection, privacy, ownership, governance and security when they use digital technologies with students (UNESCO, 2022). Data privacy appears to be an emerging theme in research for online PE teaching (Barber and Walters, 2021), although when asked by teachers, few have brought it up as concerns for training in TPACK-21-PE (Beyranvand and Mohamadi Zenouzagh, 2021; Valtonen et al., 2020).

The use of technologies for PE among general education schoolteachers were greater than those SECS teachers. Although reviews have been published on technology and primary teachers, few studies include special education teachers or in the domain of PE (Scherer et al., 2019; Wijnen et al., 2023). There appears to be a lack of data that could be used to help verify our findings and this might be a direction for further research work, particularly as more education systems embrace the process of inclusion (Ramberg et al., 2018). Researchers in special education teacher training have suggested that assistive technologies can be beneficial for students with SEN (Nam et al., 2013). Furthermore, updates to the PE component of the European Standards in Adapted Physical Activity have included standards that relate to the use of technologies in PE (Ng et al., 2021). One explanation for lower technology use among SECS teachers could be that the teachers may focus on the physical aspect of PE (Evans, 2004) and is an opportunity to take time away from the regular digital technology use in other subjects, thus acting as a potential digital detox zone (Baykal et al., 2020). Such explanations require further research to confirm this.

Teachers who work and have undergone training to work with students with disabilities would be expected to have greater self-efficacy beliefs (Morley et al., 2021; Nowland and Haegele, 2023). Our results confirmed this, with SECS teachers having higher levels of self-efficacy across the three disability groups than general education schoolteachers. Other studies have also shown improvements in self-efficacy across pre-service teachers who were exposed to training in APE (Nowland and Haegele, 2023). Therefore, when general education schoolteachers have multiple of responsibilities, there may be less specialism to feel confident to teach children with disabilities in the PE lesson. Appropriate training for incorporating children with disabilities is needed among general PE teachers (Morley et al., 2021). There were also differences in the levels of self-efficacy depending on the type of disability students have. Similar to earlier research, self-efficacy to teach children with VI was lowest compared to children with ID or PD (Selickaite et al., 2019).

All in all, when SECS teachers have the highest levels of self-efficacy, but lowest technology use. It was not surprising that in our results, we found no direct effect between technology use and self-efficacy, as this would confirm the context specificity requirements outlined in self-efficacy theory (Bandura, 1977). Yet, when treating TPACK as a mediator, more specifically PCK, there was the presence of a total effect between technology use and self-efficacy. With the origins of TPACK coming from Shulman's PCK concept (Shulman, 1986), it seems highly relevant for a relationship to exist between this mediator and the outcomes. Overlaps between PCK in PE can include concepts such as, applying universal design for learning principles in PE (Van Munster et al., 2019). In short, the universal design for learning principles enable teachers to reduce barriers to participation in lessons by

offering multiple means of representation, action and expression, as well as engagement (Grenier et al., 2017).

TPACK-21-PE was an extension to the typically reported concept of TPACK. TPACK was a measure of teacher's knowledge on technology as a tool to support and enhance subject specific pedagogical practices (Koehler et al., 2007). The links between technology use and knowledge in technology may be a source of three of the fundamental tenants of self-efficacy theory, namely, mastery accomplishments, vicarious experiences, or even verbal persuasion, which ultimately contribute to greater levels of self-efficacy (Bandura, 1977). Such findings support the recent addition of technological components to the APE domain of the European Standards in Adapted Physical Activity (Ng et al., 2021) as a way to address the advances of PE in a digital society (Barber and Walters, 2021). Moreover, the impact of COVID-19 was a digital transformation in the education sector, giving teachers the experience of using technology for teaching purposes, including experiences in PE (Centeio et al., 2021). As such, PE teacher training could embrace further the use of technology as a source to boost self-efficacy when it comes to working with children with disabilities. As technologies become more available in schools, and use of technologies are used for everyday use, it is insufficient for teachers to be confident in teaching students with disabilities without acknowledging the use of technology. Valtonen and colleagues (2020) interviewed teachers who used TPACK and found some were confident in certain aspects of this framework and found other areas challenging. Based on this, training of teachers need to not only be practical with applied experiences, acquiring technological knowledge would also be an asset to increasing self-efficacy of teachers.

To conclude, fostering high self-efficacy in teachers in inclusive PE is needed. It would allow a place where children with and without disabilities would do PE together. Opportunities that involve technology integration fall in line with 21st century skills, particularly at a time where diversity amongst students is increasing. There are many advantages in using technology to facilitate teaching, including classroom videos and interactive boards for teaching, as well as online resources for planning sessions. In this way, positive experiences in PE by all students in the class would, in theory, lead to students' maintenance to a physical active lifestyle due to improvements in health, motor skills and social experiences (Whitehead, 2010), despite differences in abilities.

Limitations and Future Directions

The results infer relationships between the variables, although it is based on cross-sectional research, no causality can be stated, rather the directions are theoretical and would need testing through high quality intervention or longitudinal studies. The cultural differences were not analysed as the data were pooled. The measures of teachers' self-efficacy were solely on their perceptions to teach children with disabilities into a regular PE class. The vignettes were helpful for teachers to have people for each disability type. Although useful for stability in using the instrument, this could also limit the scope and breath of different types of disabilities in the class. The omission to seek perceptions of competence to use technology was not asked and may have yielded different results if treated as a confounder to the relationship between the variables. The sample was made up from a convenient sample of existing teachers, which may limit the generalizability of the findings for other teachers in the recruited countries, or in other countries. Despite such limitations, the findings from this study can be useful when considering teachers' use in an inclusive environment for primary school PE.

Conclusions

As with technology in PE, including children with disabilities into general PE, has been increasing and continues to increase across primary schools. This study examined the mediating effect of the TPACK-21-PE framework on the relationship between technology use and teacher-efficacy from primary school teachers in Europe. With technology lower, but self-efficacy higher among SECS teachers than general teachers, the mediation of TPACK appears to be an important link. Relevant training of teachers to use technology in PE is needed to bridge differences in self-efficacy of teachers in general schools and technology use of SECS teachers. The use of technology can be used for both lesson planning as well as a pedagogical tool for inclusive physical education. The findings from this study demonstrate further that the current standards in adapted physical activity require technological integration, even at the primary school level. These standards can be used across European countries to inform development of programs that integrate APE or as standalone programs.

Ethics approval and informed consent

Due to the non-invasive nature of the study with adult participants through surveys, this type of data collection did not require institutional ethical approval from the lead author's ethics committee.

Competing interests

There are no competing interest for any commercial associations or financial interests held by the authors.

Funding

The study was cofunded by Erasmus+ programme for the "Empowering primary school teacher to include students with special education needs into physical education classes using digital tools" under Grant 2021-1-LT01-KA220-SCH-000030378. The funders were not involved in the data collection, analyses or reporting of the results.

Acknowledgments

The authors acknowledge the teachers who completed the survey. In addition to the adapted physical activity specialists who reviewed the instrument, and Ritva Koistinen who checked on the translation of the measures. The authors would like to acknowledge Teemu Valtonen for sharing the TPACK-21 and Martin Block for SE-PETE-D.

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