Analysis of TPACK (Technological Pedagogical Content Knowledge) ability Physical Education teacher's

Análisis de la competencia TPACK (Conocimiento Tecnológico Pedagógico del Contenido) del profesorado de Educación Física

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Abstract

Introduction: Lifestyle changes in the 21st century will certainly affect the use of technology, requiring teachers to be able to develop learning with the use of ICT. In the subject of physical education integrating technology meaningfully is not easy, physical education teachers must master the material to be taught, so that they can choose technology according to the character of the material.
Objective: The objective of this study is to examine the analysis of TPACK ability in physical education teachers in terms of age, length of service and type of educational unit.
Methodology: The type of research is comparative. Sampling technique with purposive sampling in teacher professional program participants, with a total sample of 256 people. Research instrument using TPACK questionnaire. Data analysis techniques using Kruskal-wallis test with a significant level of 5%.
Results: 1) Physical education teacher's TPACK ability for TK variables belongs to the moderate category (48.8%), PK belongs to the moderate category (59.7%), CK belongs to the moderate category (58.9%), TCK belongs to the good category (72.3%), TPK belongs to the moderate category (58.9%), PCK belongs to the good category (71.8%), and TPACK belongs to the moderate category (71.8%). 2) TPACK ability based on age, only the PK variable has significant differences and the PK ability is best at the age of 21- 40 years, while other variables have no significant difference. 3) TPACK ability based on educational units, from all educational units of each TPACK variable there is no significant difference. 4) TPACK ability based on service life, only the PK variable has a significant difference, with the best PK ability being in the working period of < 5 years, while the other variables do not have a significant difference, and 5) Analysis of factors that affect TPACK ability, age is the factor that most affects kindergarten ability, while for other variables each factor does not have a significant effect.
Conclusions: The average TPACK ability of physical education teachers including the moderate category and there are significant differences for the PK variables on age and length of service.

Keywords

TPACK; teacher; physical; education.

Resumen

Introducción: Los cambios en el estilo de vida del siglo XXI afectarán sin duda el uso de la tecnología, lo que obliga a los docentes a ser capaces de desarrollar el aprendizaje con el uso de las TIC. En la asignatura de Educación Física integrar la tecnología de forma significativa no es fácil, los docentes de Educación Física deben dominar el material a enseñar, de modo que puedan elegir la tecnología de acuerdo con el carácter del material.
Objetivo: El objetivo de este estudio es examinar el análisis de la capacidad TPACK en profesores de educación física en función de la edad, la antigüedad y el tipo de unidad educativa.
Metodología: El tipo de investigación es comparativa. Técnica de muestreo con muestreo intencional en participantes del programa profesional docente, con una muestra total de 256 personas. Instrumento de investigación mediante cuestionario TPACK. Técnicas de análisis de datos mediante ANOVA de una vía con un nivel de significancia del 5%. Resultados: 1) La capacidad TPACK del profesor de educación física para las variables TK pertenece a la categoría moderada (48,8%), PK pertenece a la categoría moderada (59,7%), CK pertenece a la categoría moderada (58,9%), TCK pertenece a la categoría buena (72,3%), TPK pertenece a la categoría moderada (58,9%), PCK pertenece a la categoría buena (71,8%) y TPACK pertenece a la categoría moderada (71,8%). 2) Capacidad TPACK basada en la edad, solo la variable PK tiene diferencias significativas y la capacidad PK es mejor a la edad de 21 a 40 años, mientras que otras variables no tienen diferencias significativas. 3) Capacidad TPACK basada en unidades educativas, de todas las unidades educativas de cada variable TPACK no hay diferencia significativa. 4) Capacidad TPACK basada en la vida útil, solo la variable PK tiene una diferencia significativa, siendo la mejor capacidad PK en el período de trabajo de < 5 años, mientras que las otras variables no tienen una diferencia significativa, y 5) Análisis de factores que afectan la capacidad TPACK, la edad es el factor que más afecta la capacidad de jardín de infantes, mientras que para otras variables cada factor no tiene un efecto significativo.
Conclusiones: La capacidad TPACK promedio de los profesores de educación física, incluida la categoría moderada, y existen diferencias significativas para las variables PK sobre edad y tiempo de servicio.

Palabras clave

TPACK; profesor; físico; educación.

Introduction

Implementation of the learning process in the 21st century will affect the use of technology, not only are adults technologically literate but children are faster in adapting to technological developments (Huang et al., 2022). In response to this, it is undoubtedly a challenge for an educator to adjust his learning patterns by including elements of ICT (Information Communication and Technology) (Monroe-Wise et al., 2019). Educators are expected to have basic knowledge, understanding, and skills related to innovation and information technology to provide students with knowledge in developing their digital literacy skills, so as to be able to apply them in their learning (Baumgartner, 2022). In the subject of physical education, integrating technology meaningfully into learning is not easy. In order to choose the right technology, physical education teachers must master the material to be taught, so that they can analyze the character of the material (Chaipidech et al., 2022; TalrejRajua & Kharade Kalpana, 2018). Not only that, but physical education teachers must also consider choosing teaching strategies that are in accordance with the technology used, which includes pedagogical knowledge. So, it can be concluded that in order to be able to integrate technology well, physical education teachers must master the knowledge of the content of physical education, pedagogy, and technological materials. The three pieces of knowledge interact with each other and intersect to form Technological Pedagogical Content Knowledge (TPACK) (Mishra & Koehler, 2006). A study stated that knowledge related to pedagogical content based on the use of technology should be developed in the field of physical education, which will help physical education teachers to build a solid foundation through the implementation of TPACK. The absence of TPACK implementation in physical education is considered as one of the critical problems in physical education teachers because they do not use technology in their classes (Choi & Son, 2020).

Physical education teachers are expected not only to master the material and concepts of physical education but must master how to teach and physical education learning strategies can be conveyed to students well by implementing pedagogical, professional, social, and personal competencies(Van Doren et al., 2021) . Along with the development of the industrial revolution era 4.0, technology can be used as a means to make it easier for a teacher to carry out two things, namely material (content) and how to teach (pedagogy) that are continuous and inseparable from each other (Semiz & Ince, 2012). The results of the study showed that the integration of digital technology increases students' physical activity. So it is important for physical education teachers to implement technology in the educational process to improve student learning outcomes (Botagariyev et al., 2024).

Technological Pedagogical Content Knowledge (TPACK) is the knowledge needed to integrate technology in learning) or a conceptual framework that connects pedagogical, content, and technological knowledge with the aim of creating an effective and efficient learning process with a technological framework (Hernando et al., 2018). In learning planning, a teaching foundation is needed that is the intersection between the content of the subject matter and pedagogy. A physical education teacher is expected to have good pedagogical content knowledge (PCK) in order to carry out an effective educational learning process. Furthermore, the development of TPACK from PCK by teachers is very important to do so that teaching with technology integration becomes effective. As is the case in the development of PCK, prospective teachers or teachers are actively studying various methods to prepare teachers to teach with various technologies. The challenge is how to identify teachers' learning routes in order to guide them in developing that knowledge. As an illustration of the learning route, namely how much they have been involved in activities related to the components of knowledge: technological knowledge (TK), content knowledge (CK), pedagogic knowledge (PK), content pedagogic knowledge (PCK), technological pedagogic knowledge (TPK), and technological content knowledge (TCK), a new knowledge called TPACK (Mishra, 2019; Zhang & Tang, 2021)

Based on the results of research on the ability of physical education teachers in junior high schools to implement TPACK in online learning during the Covid-19 pandemic, it is included in the moderate category, from all components researched. The ability of physical education teachers to implement TPACK in learning planning is 78%, in learning implementation is 78%, and learning evaluation is 77%. So, physical education teachers are able to implement technology, pedagogy, and content in physical education learning (Saptani et al., 2024). The ability to develop TPACK here is also influenced by several things, including the age factor of the teacher, where the factor of this age can have an effect due to the age over 40 years the teacher is no longer productive to keep up with the development of existing technology. Some facts that affect the ability of TPACK teachers are the amount of learning experience gained

with the quality of teachers in teaching. The length of teaching experience is not directly proportional to the improvement of TPACK capabilities. This is influenced by many factors, including the busyness faced by senior teachers, which causes senior teachers to be unable to take time to learn new things, especially technological advances in supporting the teaching process in the classroom. Therefore, most senior teachers still apply conventional learning methods(Ning et al., 2022) .In addition, the integration of TPACK is also adjusted to the school level, where for elementary schools, teachers still rarely implement it in learning, usually they tend to only provide video tasks with the help of parents. Meanwhile, in high schools, teachers have implemented TPACK optimally, because students can already use technology well.

In addition, the results of the study show that the teachers' experience, training, facilities and infrastructure, self-efficacy, as well as motivation are at a low level. Moreover, it is found that teaching experience, training, facilities and infrastructure, self-efficacy, as well as motivation have positive effects on teachers' TPACK (Sojanah et al., 2021). In the integration of technology, it depends on the completeness of the development of professional programs that include training on how to use and prepare reference materials, relevance to the training curriculum, and the availability of support systems, so that instructors are more skilled in developing using technology (Chua & Jamil, 2012). The psychological factor of self-confidence can determine the goals to be achieved in teaching and learning quality of physical education, even though it is weak by being influenced by experience, knowledge, and other skills, including the understanding of TPACK(Friskawati, 2021). This study aims to analyze the TPACK (Technological Pedagogical Content Knowledge) abilities of Physical Education teachers.

Method

Participants

This type of research is comparative causal, to examine possible cause-and-effect relationships in a way based on observations of existing consequences, re-examining factors that may be the cause through certain data.

The research was conducted on physical education teachers who participated in the in-service teacher professional education program, with a sample size of 256 people selected based on purposive sampling technique. Subjects consisted of 221 men and 35 women, the sample age range was 20-58 years, coming from elementary, junior high and high school education units.

Procedure

The instrument used in this study was the TPACK questionnaire (Schmidt et al., 2016). The research instrument is used to analyze the abilities of TK, CK, PK, PCK, TPK, TCK, and TPACK consisting of 28 question items. The value of the instrument validity is 0.138 with a reliability value of 0.760. Data retrieval by distributing questionnaires through google form.

Statistical analysis

The data analysis technique in this study using Anova (Analysis of variances) was used to conduct multivariable comparative analysis (Rouder et al., 2016). Because the data is not normal (0.001<0.005), non-parametric analysis is needed. Multivariate analysis test to compare more than two independent samples for data where normality and homogeneity are not met using Kruskal-Wallis statistical analysis which is a nonparametric multiple comparison test that is useful for further analysis (Ostertagová et al., 2014). Kruskal Wallis test is used to distinguish the abilities of TK, CK, PK, PCK, TPK, TCK, and TPACK, based on age, educational unit and length of service.

Results

Based on the results of the distribution of the questionnaire through google form link, the description of the data can be explained as follows (Table 1).

Table 1. Distribution data of respondent

Variable	Sum	Percentage (%)
Gender		
- Male	221	86.3
- Female	35	13.7
Education Unit		
- Elementary school	190	74.2
- Junior high school	39	15.2
- Senior high School	27	10.5
Age		
- 21 – 30 years old	64	25
- 31 – 40 years old	161	62.9
- 41 – 50 years old	28	10.9
- > 50 years	3	1.2
Length of service		
- < 5 years	70	27.3
- 5 – 10 years	101	39.5
- 11 – 20 years old	83	32.4
- > 20 years	2	0.8

Based on table 1 above, it can be explained that, the most respondents were men (86.3%), the most education units were elementary schools (74.2%), the most ages were between 31 – 40 years (62.9%) and length of service the most between 5 - 10 years (39.5%).

Distribution data of respondent can be explained according to the following diagram:

Figure 1. Distribution data of respondent by gender

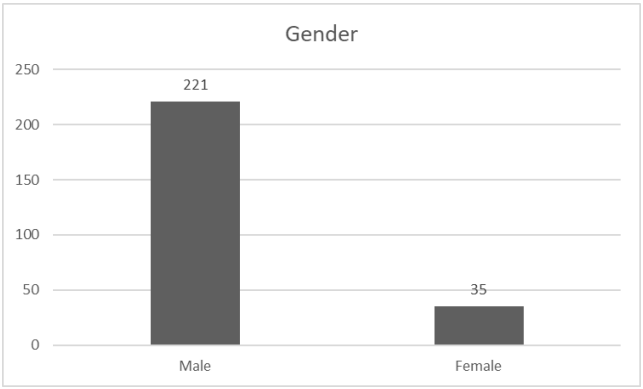

Figure 2. Distribution data of respondent by education unit

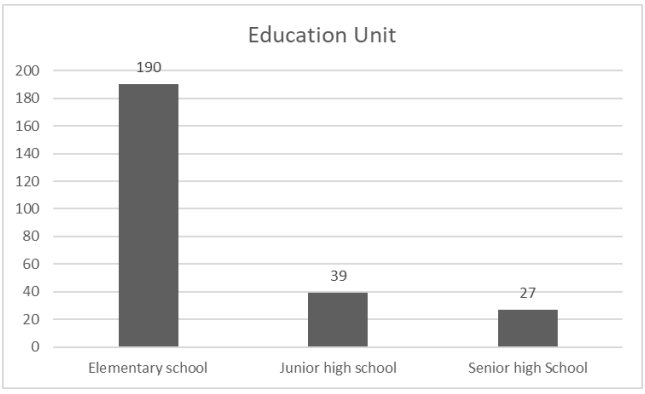

Figure 3. Distribution data of respondent by age

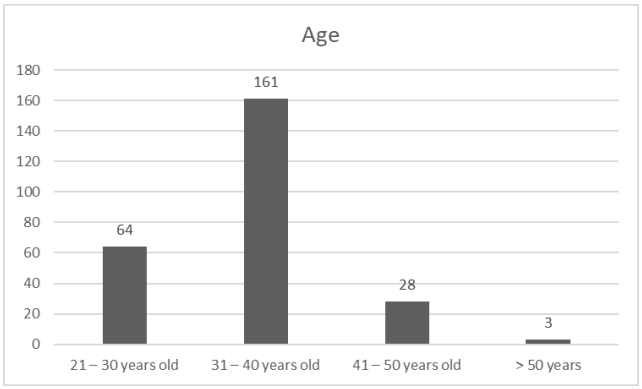

Figure 4. Distribution data of respondent by lenght of service

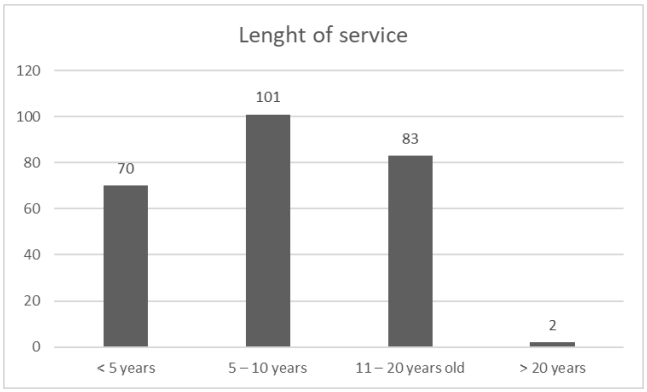

Table 2. Description of TK, PK, CK, TCK, TPK, PCK and TPACK data

Variable	N	Min	Max	Mean	SD
TK	256	6	30	23.84	3.44
PK	256	7	35	27.95	3.33
CK	256	3	15	12.13	1.41
TCK	256	1	5	4.07	0.55
TPK	256	5	25	20.52	2.32
PCK	256	1	5	3.99	0.56
TPACK	256	24	120	96.58	10.65

Based on table 2 above, it can be explained that the average for the TK variable of 23.84±3.44 belongs to the moderate category, the PK variable with an average value of 27.95±3.33 belongs to the moderate category, the CK variable with an average value of 12.13±1.41 including the moderate category, the TCK variable with an average value of 4.07±0.55 including the good category, the TPK variable with an average of 20.52±2.32 including the moderate category, the PCK variable with an average value of 3.99±0.56 including the good category and the TPACK variable with an average value of 96.58±10.65 including the moderate category. As for the category of TPACK ability of physical education teachers, it can be described in table 3 below.

Based on table 3 above, it can be explained that for the TK variable the highest percentage in the moderate category (48.8%), PK in the moderate category (59.7%), CK in the moderate category (58.9%), TCK in the good category (72.3%), TPK in the moderate category (58.9%), TCK in the good category (72.3%), TPK in the moderate category (58.9%), PCK in the good category (71.8 %), and TPACK in the moderate category (71.8%). Data analysis in this study is by conducting a difference test by Anova. As for the result, it can be explained as follows.

Table 3. Categories of TPACK Capabilities (TK, PK, CK, TCK, TPK, PCK)

Category	Variable						
	TK	PK	CK	TCK	TPK	PCK	TPACK
Very Less	15(5.9%)	14(5.5%)	9(3.51%)	1(0.39%)	16(6.2%)	1(0.39%)	13(5.1%)
Less	31(12.1%)	41(16%)	37(14.45%)	0(0%)	37(14.4%)	0(0%)	52(20.3%)
Moderate	124 (48.4%)	153 (59.7%)	151 (58.9%)	24 (9.4%)	151 (58.9%)	35 (13.7%)	131 (51.2%)
Good	60(23.4%)	23(8.9%)	35(13.7%)	185(72.3%)	19(7.4%)	184(71.8%)	38(14.8%)
Excellent	26(10.1%)	25(9.7%)	24(9.4%)	46(17.9%)	33(12.9%)	36(14.1%)	22(8.6%)
Total	256	256	256	256	256	256	256

Table 4. Kruskal Wallis Test of Physical education Teacher's TPACK ability by Age, education unit and length of service

Variable	Age		Education unit		Length of service	
	Chi-Square	Sig	Chi-Square	Sig	Chi-Square	Sig
TK	5,286	0,152	1,211	0,546	5,286	0,152
PK	12,730	0,005	0,589	0,745	12,730	0,005
CK	1,521	0,677	5,155	0,076	1,521	0,677
TCK	4,861	0.182	3,657	0,161	4,861	0,182
TPK	3,763	0.288	0,410	0,815	3,763	0,288
PCK	6,318	0.097	2,230	0,328	6,318	0,097
TPACK	2.700	0.440	0,922	0.631	2,700	0,440

Based on table 4 above, it can be explained that of all the age levels of each TPACK variable, only the PK variable has a significant difference ($\alpha < 0.005$) with good PK ability is at the age of 21-30 years and 31 and 40 years, while the other variables have no significant difference ($\alpha > 0.005$). It can be explained that from all educational units of each TPACK variable there is no significant difference ($\alpha > 0.005$). While, it can be explained that of all the length of service life of each TPACK variable, only the PK variable has a significant difference ($\alpha < 0.005$) with good PK capability is at a service period of < 5 years, while the other variables do not have a significant difference ($\alpha > 0.005$).

Discussion

Based on the results of the study, it can be explained that the average TPACK ability of PJOK teachers is included in the medium category (71.8%), while from each variable it can be explained that for the PK, TK, CK and TPK variables enter medium category, while TCK and PCK are in the good category. This is in line with research related to the ability of TPACK physical education teachers in online learning to state that the average is in the moderate category (Girard & Vors, 2021).

Of all the age levels of each TPACK variable, only the PK variable that has a significant difference ($\alpha < 0.005$) with good PK ability is at the age of 21-40 years, while the other variables did not make a significant difference ($\alpha > 0.005$). The results of the study explain that technological knowledge and self-efficacy towards computers are significantly higher in teachers under the age of 36 years (Ladrón et al., 2019). Pedagogical knowledge (PK) is the ability of a teacher to design learning or compile a learning plan. Where teachers are required to understand related to the implementation of innovative learning models in learning in the 21st century. Teachers are required to have the ability to plan the learning they get from trainings organized by teacher working groups and organized by the office education (Candra et al., 2020). When viewed in terms of age, teachers with ages ranging from 21-40 years have a high enthusiasm in improving their competence through understanding related to PK in planning the learning process, compared to those who are more than 40 years old. This is in accordance with the results of research in Chile, which recommends that there needs to be an institutional mechanism related to socialization to improve new skills and knowledge about technology, because the lack of training in these skills can cause problems in integration into the new digital society that is developing. In addition, there is a gap between generations in the use of this type of technology, which can have an impact on older ages (Alexis Matheu Pérez, 2024).

From all the educational units of each TPACK variable, there was no significant difference ($\alpha > 0.005$). It means that a teacher from all levels of education unit is expected to always update information related to the integration of technology in teaching and in emerging physical education and sports-related tech-

nologies. Teacher professional education is expected to provide support to teachers with the latest educational technology, and research is needed related to the reasons for the rare use of physical education and sports technology in physical education teachers (Semiz & Ince, 2012). So physical education teachers must learn how to integrate technological knowledge into teaching and make TPACK knowledge will improve the learning process of physical education for the better (Lee et al., 2020).

Meanwhile, of all the working periods of each TPACK variable, only the PK variable that has a significant difference ($\alpha < 0.005$) with good PK ability is in the service period of < 5 years, while the other variables do not have a significant difference ($\alpha > 0.005$). The period of service will give an idea related to the level of professionalism of a teacher. When viewed from the ability of pedagogical knowledge (PK), teachers who have a work period of <5 years are fresh graduates from universities in the field of education, so that their knowledge of How the implementation of innovative learning models in 21st century learning is more updated than physical education teachers with longer service life. PK is an understanding of the learning process and the ability to control the learning process. PK is a form of general knowledge about cognitive, social and development learning theory (Valtonen et al., 2017). Teacher's ability in mastering pedagogical knowledge needs to be improved, especially in carrying out the assessment process (Surahman et al., 2020). Age, length of teaching and gender factors had no significant effect or little effect on the TPACK components. Therefore, learning is required to be able to adapt to technological developments in order to make learning more effective and dynamic (Ismail et al., 2022).

The teacher professional education program is expected to provide models and experiences that are conducive to teaching physical education teachers effectively how to combine physical education content, technology, and teaching approaches appropriately. Another study provides information to reduce difficulties in prohibiting TPACK skills, through a digital guidebook for teachers, so that it does not create barriers to understanding the contents, equipped with effective video tutorials (Celik et al., 2023). Therefore, in order to successfully realize a paradigm in education that prioritizes the use of technology and other digital platforms, teachers must be equipped with TPACK (knowledge, content, pedagogy, and technology) through ability development activities that take into account their abilities, demographics and background (Tanucan et al., 2021). Basically, General Content Knowledge and Specific Content Knowledge need to be taught better in teacher education programs, because they are the foundation for Pedagogical Content Knowledge. In addition, because this concept is dynamic and changing, it should also be considered in the professional development phase, because field experience can provide new knowledge and experience for pre-service teachers (Noelva Eliana Montoya, 2023).

Conclusions

1. The ability of physical education teachers in implementing TPACK is included in the moderate category (TK, CK, PK, TCK, PCK, TPK).
2. TPACK ability based on age, only the PK variable has a significant difference and the best PK ability is at the age of 21-30 years and 31 and 40 years, TPACK ability from all educational units, each TPACK variable has no significant difference and TPACK ability based on length of service, only the PK variable has a significant difference, with the best ability being at length of service <5 years.
3. Based on these results, it is necessary to have training related to improving TPACK competence in physical education teachers, so that there is no gap in mastery and implementation in the learning process.

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