Examining College of Education Physical Education teachers Knowledge and skills in ICT integration in Physical Education

Abstract

This study examined the Technological Pedagogical Content Knowledge (TPACK) of Physical Education (PE) tutors in Ghanaian Colleges of Education, focusing on their knowledge and skills in ICT integration. An online survey was conducted with 46 PE tutors using a questionnaire based on the TPACK framework. Data were analyzed using descriptive statistics, correlation, and regression analyses. Results indicated that PE tutors exhibited high levels of knowledge across all TPACK constructs, with particularly strong scores in Content Knowledge, Pedagogical Knowledge, and Pedagogical Content Knowledge. Technological Knowledge and Technological Content Knowledge showed relatively lower scores. Significant correlations were found between most TPACK constructs, with Technological Pedagogical Knowledge emerging as the strongest predictor of overall TPACK. Surprisingly, Pedagogical Content Knowledge negatively predicted TPACK. These findings provide insights into the readiness of Ghanaian PE tutors to integrate ICT into their teaching and highlight areas for targeted professional development. The study contributes to the limited research on TPACK among PE tutors in Ghanaian Colleges of Education and underscores the importance of context-specific approaches to technology integration in specialized fields like Physical Education.

Keywords: TPACK, Physical Education, ICT integration, teacher education, Ghana

Introduction

The integration of Information and Communication Technology (ICT) in physical education (PE) has shown considerable potential to enhance student and teacher performance (Palao et al., 2015; Calabuig-Moreno et al., 2020; Batez, 2021). Despite initial hesitation, ICT is increasingly being adopted in PE classrooms (Rodrguez Quijada, 2015). Studies have demonstrated that technology-integrated PE can improve student engagement and motivation (Wyant & Baek, 2019), as well as aid underperforming students in skill development (Casey & Jones, 2011).

However, PE teachers often face challenges in integrating ICT due to lack of technological competency, knowledge, and self-confidence (Gibbone et al., 2010; Koh et al., 2020). The Technological Pedagogical Content Knowledge (TPACK) framework has emerged as a valuable tool for assessing teachers' readiness to integrate technology effectively in their teaching practices (Valtonen et al., 2020).

Faced with the new opportunities and impacts that information technology and the internet have brought to education, teachers in the twenty-first century should not only have Content Knowledge (CK) and Pedagogy Knowledge (PK), but should also be able to apply Technological Knowledge (TK) to improve students' learning effectiveness (Lee et al., 2021).

Research Questions

The study is guided by these main research questions:

1. What is the level of ICT knowledge among College of Education Physical Education Tutors in Ghana using the TPACK framework.
2. What is the correlations between the various TPACK constructs.
3. Which constructs best predict the overall Technological Pedagogical Content Knowledge (TPACK) of Physical Education tutors in Ghanaian Colleges of Education.

Literature Review

A lot of studies suggest that using ICT in schools can considerably increase the performance of students and teachers in Physical Education (Batez, 2021). Despite the initial hesitation of instructors or other persons or institutions associated with the education sector, it is evident that ICTs are increasingly penetrating the field of physical education (Rodrguez Quijada, 2015). Wyant and Baek (2019) discovered that technology-integrated PE is good at keeping kids' attention and interest, resulting in increased motivation for PE. Another study in Australia (Casey & Jones, 2011) discovered that video-analysis software can help underperforming kids grasp throwing and catching. According to numerous research, instructors regard the incorporation of technology in educational practice as a challenging innovation. The fundamental cause is that they lack technological competency, knowledge, and self-confidence. Other

researchers have argued that PE teachers' fear of integrating technology in their lectures stems from a lack of expertise (e.g., digital literacy) and inadequate training in using the tools/gadgets (Gibbone et al., 2010; Koh et al., 2020). Certain elements, according to Koh et al. (2022), affect both teachers and students in an endeavor to integrate technology in Physical Education. Three major factors have been identified as having an effect on Technology adoption in PE: (a) technological dispositions (i.e. self-efficacy and open-mindedness); (b) teaching approaches (i.e. pedagogical integration; cognitive, affective, and psychomotor stimulation; and balanced integration of ICT and the traditional approach); and (c) contextual factors (i.e. technological conditions; cultural conditions; and teachers' ICT-specific PE knowledge). The findings further supported the notion that effective use of ICT tools has the ability to favorably influence teaching and learning during PE lessons, while emphasizing the necessity for schools and professional development organizations to increase PE teachers' ICT pedagogical expertise.

Liu (2021) investigated TPACK Physical Education teachers in Hubei, Jiangxi, Hunan, Guangdong, and other Chinese regions. According to the findings, more than half of the PE tutors believe that incorporating information technology into physical education will improve its efficiency. Furthermore, the tutors acknowledged that technology use in PE may have both positive and negative effects, but the positive outweighs the negative. Furthermore, the study found that physical education instructors' TPACK levels are unevenly distributed, with the mean value of each dimension TPACK<TPK<TCK<TK<PCK<PK<CK. TPACK (integrated technology subject teaching knowledge) had the lowest overall score, while CK (subject knowledge) received the highest. As a consequence, he concluded that physical education teachers have a stronger grasp of sports professional knowledge, and their sports professional knowledge can better meet the needs of daily instruction.

Tanucan et al., (2021) conducted research on Filipino physical education instructors' awareness of technological pedagogical content on remote digital teaching. Using a descriptive correlational research design, the study examined their preparedness for remote digital instruction using the TPACK model, the relationship between their demographics, and the seven aspects of knowledge of the TPACK model and its interrelationship. The study's findings revealed that 1) PE teachers have an average level of preparedness to conduct remote digital teaching in all domains of TPACK knowledge; 2) the preparedness level of PE teachers to conduct remote

digital teaching in all domains of TPACK knowledge is dependent on their age, gender, and teaching experience, with the exception of technological knowledge, which is independent of their highest educational attainment; and 3). There is a considerable correlation between all TPACK areas of knowledge and PE teachers' preparedness to perform remote digital teaching.

Krause and Lynch (2018) used a multiple case study methodology to assess the TPACK-related experiences of 13 professors and 32 students from three PETE programs. The findings examined various experiences with TPACK training, faculty modeling of technology, and technology incorporation into field experiences. Lee et al. (2021) investigated Chinese PEPT design thinking and the links between Technological Pedagogical Content Knowledge and PEPT design thinking (TPACK). The findings show that the instrument has strong construct, discriminant, and convergence validity, as well as reliabilities. The TPACK was significantly and favorably linked with the design thinking questionnaire of all components. The path analysis demonstrates that divergent design thinking can anticipate TCK, TPK, and TPCK. It is worth noting that design thinking's convergent thinking can also predict TCK.

Martnez-Rico et al., (2021) investigated two primary PEITEs' professional learning experiences while adding iPads into a physical education curriculum. The findings suggested that time was a valuable asset for the PEITEs when contending with technology expertise, technological pedagogical knowledge, and pre-service teachers' physical education understanding. Self-directed learning facilitated the PEITEs' technological and pedagogical competence. Lee et al., (2020) investigated the connections between teachers' Technological Pedagogical Content Knowledge (TPACK) and Teacher Professional Development (TPD) (TPD). The findings showed that pre-service teachers' TPACK was highly connected with their TPD. Finally, route analysis revealed that pre-service teachers' PCK and TCK might considerably predict their TPD.

Martnez-Rico et al., (2022) investigated the technological resources and challenges that Physical Education teachers face in the classroom, as well as the training and methodological strategies required to adequately teach Physical Education classes in modern times. The researchers assessed instructors' Digital Competence and whether there are gender variations based on age and teaching experience. The findings reveal statistically significant differences based on teaching experience and age. Furthermore, younger instructors had a more positive assessment of their abilities to utilize Digital Competence in the Physical Education classroom.

Golder and Tearle (2008) looked at how the course, which is offered at both universities and schools, attempted to encourage trainees' use of ICT in PE and then identified areas where the program could be improved in this regard. The study found that trainees, university tutors, and school-based PE teachers were enthusiastic about using ICT in teaching and learning PE, and were willing to adapt their practices to accommodate this. It also indicated a serious absence of subject-specific professional development, as well as a pervasive lack of awareness of demands, all of which were thought to have contributed to the lack of relevant ICT resources to which most school PE departments had access. Casey and Jones (2011) emphasized the effectiveness of video technology in increasing engagement, implying that such a level of commitment assisted Physical education students in developing understanding beyond technical replication and toward rational and reasoned student investigations around their learning. Furthermore, it made students feel less marginalized and allowed them to be more involved in their learning.

Valtonen et al., (2020) expanded on research that assess pre-service teachers' confidence in Technological Pedagogical Content Knowledge (TPACK). According to the findings, respondents said that PK, TK, PCK, and TPK were the TPACK categories in which they were confident or challenged. The most often referenced locations were TPK and PK. The TPACK regions that were not mentioned were CK, TCK, and TPACK itself. According to the literature, ICT integration into PE has a lot of potential in the classroom. Furthermore, the research emphasized the advantages of PE teachers using TPACK in the efficient use of ICT in the teaching and learning of Physical Education.

While these studies provide valuable insights into PE teachers' TPACK in various settings, there is limited research focusing specifically on PE tutors in Colleges of Education in Ghana. Most of the existing research has been conducted at senior high schools and universities, with minimal attention given to colleges of education. This study aims to address this gap by examining the ICT knowledge and skills (TPACK) of PE tutors at Ghanaian colleges of education, providing insights into their readiness to effectively integrate ICT into their teaching practices.

Methodology

The study employed a quantitative approach, utilizing an online survey to examine the Technological Pedagogical Content Knowledge (TPACK) of Physical Education (PE) tutors in

Ghanaian Colleges of Education. The target population comprised all PE teachers in the institutions, with population of 98 tutors. From this group, 46 Physical Education tutors participated in the survey, forming the study sample.

The research instrument was an online questionnaire developed based on the seven constructs of the TPACK framework. The items were adapted from previous studies by Archambault and Crippen (2009) and Sahin (2011). To ensure reliability and validity, the questionnaire underwent pilot testing with nine PE tutors from three colleges of education. The reliability coefficients for the TPACK subscales ranged from 0.735 to 0.909, with an overall reliability of 0.932, indicating high internal consistency.

Data Collection and Analysis

The responses from the online survey were exported to SPSS version 21.0 for analysis. The data were analysed using descriptive statistics such as means and standard deviations, correlation and regression. The data were analysed based on the research questions.

Research Question One: What is the level of College of Education Physical Education Tutors in ICT Knowledge? Means and standard deviations were used to determine the ICT knowledge level of PE tutors in colleges of Education in Ghana. The results are shown in Table 1.

Table 1 - College of Education Tutors ICT Knowledge Level

TPACK Construct	Mean	Std. Deviation
Technological Pedagogical Content Knowledge	4.1778	.63564
Technological Knowledge	3.5556	.77784
Content Knowledge	4.0222	.95914
Pedagogical Knowledge	4.2540	.60830
Pedagogical Content Knowledge	4.0000	.82572
Technological Content Knowledge	3.8889	.74536

Technological Pedagogical Knowledge	4.0667	.68091

Teachers exhibit a high level of knowledge in the integration of ICT in the teaching and learning of Physical Education. Physical education tutors in Colleges of Education exhibit a high level of knowledge in all constructs of TPACK. The mean scores of the college of Education physical education tutors score high mean scores in TPACK, CK, PK, PCK and TPK. However, the mean scores of Technological Knowledge and Technological Content Knowledge are a bit lower than the other constructs. The highest scores in CK, PK and PCK are not surprising because the teacher education concentrated more on the teaching of content and pedagogy and the blend of both the content and pedagogy. However, the lowest scores in the Technological knowledge and Technological Content Knowledge could be that the teacher education did not give much concentration to technological knowledge and the blending of technology and content knowledge. This is shown in Table 1 below.

This contradicts Tanucan et al (2021) result that PE teachers have an average degree of preparedness to undertake remote digital teaching in all domains of TPACK expertise. The findings are consistent with the notion that Indonesian teachers possessed enough TPACK competencies for integrating technology-based learning (Surahman et al., 2020). Except for the Technological Knowledge (TK) component, the respondents' average TPACK competency score is in the high range. Meanwhile, the components CK, PK, PCK, TPK, and TPACK are of good quality.

This finding, however, also contradicts the findings of Nopembri, Listyarini, and Muktiani (2020), who investigated the knowledge and utilization (literacy) of ICT-based instructional media for Physical Education teachers and concluded that knowledge and utilization of ICT-based instructional media on PE teachers differ from one another, although most are in the moderate category. This demonstrates that the literacy of PE teachers on ICT-based instructional material is still influenced by a variety of factors, including knowledge acquisition and use. PE teachers will require a variety of education and training processes to improve their literacy of ICT-based instructional material. Furthermore, Bisgin (2014) considers the lack of ICT

competence among PE teachers as a significant hurdle to incorporating them into their teaching process.

Research Question Two: What is the correlation between the various TPACK constructs? The correlation coefficient was used to determine the correlation between the various PE tutors' TPACK constructs. The result is shown in Table 2.

Table 2-

Correlation between College of Education Physical Education Tutors TPACK

TPACK CONSTRUCT	TK	CK	PK	PCK	TCK	TPK	TPACK
TK		.066	.607**	.329*	.641**	.591**	.866**
CK			.469**	.172	.226	-.009	.053
PK				.517**	.529**	.468**	.636**
PCK					.739**	.849**	.650**
TCK						.731**	.858**
TPK							.833**

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Technological Knowledge was strongly correlated with pedagogical knowledge and technological pedagogical content knowledge with other positive significant correlations with CK, PCK and TPK. Content Knowledge (CK) correlated significantly with pedagogical knowledge. PK correlated significantly with PCK, TCK, TPK and TPACK. Also, there is a positive correlation between PCK and TPACK. The strongest correlation was found between TCK and TPACK followed by PCK and TPK and finally TPK and TPACK. However CK did not correlate significantly with PCK, TCK TPK and TPACK as depicted in the TPACK Venn diagram, but there was a correlation between PK and CK which was contrary to the depiction of these constructs in the TPACK framework. There was a correlation between each basic construct (content, pedagogy and technology) and the intersection construct, TPCK. The correlations were followed with regression to determine how each of the constructs predicts the intersection construct TPCK as shown in Table 2. This study is supported by the study conducted by Tanucan

et al., (2021) who pointed out that PE teachers' primary knowledge levels (TK, PK, and CK) were strongly associated with the rest of the knowledge domains. This indicates that to properly implement their courses utilizing the remote digital teaching technique, teachers must have a solid understanding of their subject matter's core primary knowledge (CK), teaching and learning approaches (PK), and various technological or digital platforms (TK) (Tanucan et al., 2021)

Research Question Three: Which constructs best predicts college of education physical education teachers' knowledge level? This was analysed using linear multiple regression. The results are shown in Table 3.

Table 3-*Coefficient of Predictors (TK, PK, PCK, TCK, TPK) On TPACK*

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.350	.169		2.069	.045
TK	.237	.055	.290	4.294	.000
PK	.198	.057	.189	3.501	.001
PCK	-.171	.071	-.222	-2.408	.021
TCK	.376	.053	.441	7.119	.000
TPK	.409	.079	.438	5.203	.000

a. Dependent Variable: TPACK

Multiple R = 0.982, R^2 = 0.965, Adjusted R^2 = 0.960, Standard Error = 0.127, F (6, 38) = 174.891, *Significant at P* < 0.05

To determine the predictors of the college of education physical education tutors' knowledge in ICT, a multiple regression analysis was conducted. The overall Model was significant at F (6, 38) = 174.891 at P = 0.00. It could be seen that approximately 96.5% of the variation in tutors'

TPACK is explained by the variations in TK, PK, TPK, PCK and TCK. Since the F-calculated is in the region ($p < 0.05$), there is evidence that at least one of the constructs influences college of education Physical education tutors. From the standard coefficient, tutors TPK appears to be the strongest predictor of tutors TPACK followed by tutors TCK, then TK while the least predictor was PK. However, PCK negatively predicted the tutor's TPACK. This show that, tutors' TPACK is strongly influenced by TPK followed by TCK whiles TK was the least influence on tutors' TPACK. This is consistent with the findings of Ifinedo et al's (2019) study, which found that teachers' primary knowledge levels, such as TK, PK, and CK, are strong predictors of their respective second-level knowledge bases, TPK, TCK, and overall TPACK. In other words, while implementing a new teaching strategy, particularly one that incorporates technology, it is necessary to consider the instructors' curricular, pedagogical, and technological knowledge. This study contradicts the findings of Chai et al.'s (2010) in their study on encouraging the development of technological, pedagogical, and topic knowledge in pre-service teachers (TPACK). According to regression analysis, technological knowledge, pedagogical knowledge, and content knowledge are all important predictors of pre-service teachers' TPACK, with pedagogical knowledge having the most influence.

Conclusion and Recommendation

The study concludes that PE tutors in Ghanaian Colleges of Education possess a high level of knowledge in ICT integration, particularly in terms of their overall TPACK. However, there are areas for improvement, especially in Technological Knowledge and Technological Content Knowledge. The unique patterns observed in this study, such as the lack of correlation between CK and other constructs and the negative prediction of TPACK by PCK, highlight the need for context-specific investigations in understanding and developing teachers' technological, pedagogical, and content knowledge.

Based on these findings, several recommendations can be made. Targeted professional development programs should be designed to enhance tutors' Technological Knowledge and Technological Content Knowledge, addressing the identified areas of relative weakness. Secondly, teacher education curricula should emphasize the integration of technology with both pedagogy and content, given the strong predictive power of TPK and TCK on overall TPACK. Further research is needed to understand the unique patterns observed in this study, particularly

the lack of correlation between CK and other constructs, and the negative prediction of TPACK by PCK in this context and also because the current study is limited to tutor knowledge and skills (TPACK), additional research can be done to evaluate how PE in colleges of education efficiently use ICT in their teaching.

In essence, this study not only contributes to our understanding of TPACK among PE tutors in Ghanaian Colleges of Education but also highlights the complexities of technology integration in education. It underscores the need for nuanced, context-specific approaches to teacher development and ICT integration, particularly in specialized fields like Physical Education. As we move forward, these insights can guide the development of more effective teacher education programs and professional development initiatives, ultimately enhancing the quality of PE instruction in the digital age.

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