

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

Commented [s1]:

Abstract

The aim of this study was to examine college of education Physical Education (PE) teachers' knowledge in ICT integration. The population for the study included all the physical education tutors in the colleges of Education in Ghana. An online survey was used to collect data from 46 tutors using questionnaire. The data were analysed using descriptive statistics such as means and standard deviations, correlation and regression. The results indicated that physical education tutors in Colleges of Education exhibits high level of knowledge in all construct of TPACK. In addition, the results also highlighted that Technological Knowledge strongly correlated with pedagogical knowledge and Technological pedagogical content knowledge with other positive significant correlation 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. 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 tutors TPACK.

Keywords: content knowledge, pedagogical knowledge, technology knowledge, information, communication and technology, integration

Commented [s2]: Physical Education, TPACK

Introduction

With the rapid development of sophisticated technologies, it has now become a fundamental quality that teachers should employ (Lee, Chang & Liang, 2020). Faced with the new opportunities and impacts that information technology and the internet have introduced 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 technology knowledge (TK) to improve students' learning effectiveness (Lee, Chang & Liang,, 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, Chang & Liang, 2021).

Commented [s3]: Mention the relevance of physical teachers relevance in higher education and their duties. Explain how technology is useful in physical 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 (Palao, Hastie, Cruz, and Ortega, 2015; Calabuig-Moreno, González-Serrano, Fombona, and Garcón, 2020; 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

Commented [s4]: Interoduction should followed by solid literature review. Thorough, relevant L.R. helps to find out the research gap.

Commented [s5]: Without research gap research work is not valid.

Commented [s6]: After finding the gap set objectives for the study

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, Rukavina & Silverman, 2010; Koh, Li & Mukherjee, 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, Hernani, and Diano (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, Alberola-Albors, Pérez-Campos, and González-Garca (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, Chang, and Liang (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, Alberola-Albors, Pérez-Campos, and González-Garca (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, Leppänen, Hyypiä, Sointu, Smits, and Tondeur (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. The majority of the research was done at senior high schools and universities, with limited attention on education colleges. Finally, few research on PE teachers' knowledge and skills (TPACK) at Ghanaian colleges of education have been undertaken. This will help to determine whether PE teachers have the necessary skills to properly integrate ICT into their teaching.

Methodology

The study employed an online survey to collect data from Physical Education tutors in the colleges of Education. The population consist of all Physical Education Teachers teaching at the College of Education in Ghana. An online survey was used to collect quantitative data from 45 Physical Education Tutors in Ghanaian Colleges of Education. An online questionnaire was developed based on the seven constructs of the TPACK framework to collect the requisite data. The items were adopted and adapted from Archambault and Crippen (2009) and Sahin (2011). Since the items were adapted, the refined questionnaire was transformed into an online survey through the Qualtrics Survey Software. It was then piloted on a small group of Physical Education teachers. The online questionnaire was sent to Physical Education tutors in three colleges of education for them to try it out. Nine teachers completed the trial/pilot online questionnaire. The responses of these nine tutors were collated and used to determine the reliability of the online questionnaire before it was sent out for the main study. The reliability co-efficient of the sub-scales of TPACK are: TK (0.839), CK (0.735), PK (0.749), PCK (0.909), TCK (0.844), TPK (0.825) and TPACK (0.903) with the overall reliability of 0.932. This indicated that the questionnaire were reliable for the collection of Physical Education tutors knowledge in ICT. The questionnaire was designed in Google drive and the link to the questionnaire were sent to the various head of departments for the onward submissions to their whatsapp platforms. The questionnaire contain the name and institution of the researcher, the reasons for the survey and the duration it may take to respond to the survey. Tutors' anonymity was assured and their consent was sought in the first page of the questionnaire. This was done to assure teachers confidentiality of their responses before they response to the questionnaire. A thank you note was added to the link to thank the tutors for their time in advance. The respondents had to click on the Google link in their whatsapp platform in order to get access to

the survey. Respondents then provided responses to the various items on the questionnaire. Respondents had the option of pausing and returning to the survey at a later time. Responses were collected via Google documents.

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.

Commented [s7]: Mention the characteristics of the data collected. Sample size should represent the population.

Commented [s8]: Menti limitations and future scope for research

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

Commented [s9]: Define mean and std.dev. what is the relevancy to use these two?

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	-	.021
				2.408	
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, Saarela, and Hämäläinen'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, Hwee, Koh, and Tsai (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 purpose of this study was to assess college-level Physical Education (PE) teachers' understanding of ICT integration. The findings demonstrated that physical education teachers in colleges of education have a high degree of understanding of all TPACK constructs.

Commented [s10]: Research work should fulfil all the objectives. Without objectives what do you want to study?

Commented [s11]: Mention findings of your study

Commented [s12]: Without discussion part your research work is not published.

Furthermore, the findings revealed that Technological Knowledge was substantially associated with Pedagogical Knowledge and Technological Pedagogical Content Knowledge, as well as other positive significant correlations with CK, PCK, and TPK. Content Knowledge (CK) was found to be significantly connected to pedagogical knowledge. PK had a strong relationship with PCK, TCK, TPK, and TPACK. There was also a favourable relationship between PCK and TPACK. TCK and TPACK had the highest link, followed by PCK and TPK, and finally TPK and TPACK. However, CK did not have a significant correlation with PCK, TCK, TPK, or TPACK. TPK appears to be the best predictor of tutors TPACK, followed by tutors TCK, then TK, with PK being the worst predictor. PCK, on the other hand, predicted teachers' TPACK adversely. 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.

Commented [s13]: Suggestions should be original, based on your observation. They must be creative and adoptive ib HEIs.

References

- Batez, M. (2021). ICT skills of university students from the faculty of sport and physical education during the COVID-19 pandemic. *Sustainability*, 13(4), 1711.
- Bisgin, H. (2014). Analyzing the Attitudes of Physical Education and Sports Teachers towards Technology. *Anthropologist*, 18 (3), 761-764.
- Calabuig-Moreno, F., González-Serrano, M. H., Fombona, J., & García-Tascón, M. (2020). The emergence of technology in physical education: A general bibliometric analysis with a focus on virtual and augmented reality. *Sustainability*, 12(7), 2728.
- Casey, A., & Jones, B. (2011). Using digital technology to enhance student engagement in

physical education. *Asia-Pacific Journal of Health, Sport and Physical Education*, 2(2), 51–66. <https://doi.org/10.1080/18377122.2011.9730351>

Chai, C. S., Hwee, J., Koh, L., & Tsai, C. (2010). *Facilitating Preservice Teachers' Development of Technological, Pedagogical, and Content Knowledge (TPACK)*. 13, 63–73.

Gibbone, A., Rukavina, P., & Silverman, S. (2010). Technology integration in secondary physical education: Teachers' attitudes and practice. *Journal of educational technology development and exchange (JETDE)*, 3(1), 3.

Ifinedo, E., Saarela, M., & Hämäläinen, T. (2019). Analysing the Nigerian teacher's readiness for technology integration. *International Journal of Education and Development Using Information and Communication Technology (IJEDICT)*, vol. 15, no. 3, pp. 34-52, 2019.

Koh, K. T., Li, C., & Mukherjee, S. (2020). Preservice physical education teachers' perceptions of a flipped basketball course: Benefits, challenges, and recommendations. *Journal of Teaching in Physical Education*, 40(4), 589-597.

Koh, K. T., Tan, L. Q. W., Camiré, M., Paculdar, M. A. A., & Chua, W. G. A. (2022). Teachers' and students' perceptions of factors influencing the adoption of information and communications technology in physical education in Singapore schools. *European Physical Education Review*, 28(1), 100–119. <https://doi.org/10.1177/1356336X211017949>

Krause, J. M., & Lynch, B. M. (2018). Faculty and student perspectives of and experiences with TPACK in PETE. *Curriculum Studies in Health and Physical Education*, 9(1), 58–75. <https://doi.org/10.1080/25742981.2018.1429146>

- Lee, H. Y., Chang, C. W., & Liang, J. C. (2020). Research on TPACK and teacher professional development of secondary physical education pre-service teachers. *ICCE 2020 - 28th International Conference on Computers in Education, Proceedings*, 2(January 2021), 579–585.
- Lee, H. Y., Chang, C. W., & Liang, J. C. (2020, November). Research on TPACK and teacher professional development of secondary physical education pre-service teachers. In *28th International Conference on Computers in Education, ICCE 2020* (pp. 579-585). Asia-Pacific Society for Computers in Education.
- Lee, H., Chang, C., & Chung, C. (2021). Research on Design Thinking and TPACK of Physical Education Pre-service Teachers. *29th International Conference on Computers in Education Conference, ICCE 2021 - Proceedings*, 2, 9–16.
- Liu, Z. (2021). A Survey of Physical Education Teachers' Technological Pedagogical Content Knowledge. *Proceedings - 2021 International Conference on Information Technology and Contemporary Sports, TCS 2021*, 30–33. <https://doi.org/10.1109/TCS52929.2021.00014>
- Marron, S., Coulter, M., & Coulter, M. (2021). *Initial teacher educators ' integrating iPads into their physical education teaching teaching*. <https://doi.org/10.1080/03323315.2021.1971103>
- Martínez-Rico, G., Alberola-Albors, M., Pérez-Campos, C., & González-García, R. J. (2022). Physical education teachers' perceived digital competences: Are they prepared for the challenges of the new digital age? *Sustainability (Switzerland)*, 14(1). <https://doi.org/10.3390/su14010321>
- Nopembri, S., Listyarini, A. E., & Muktiani, N. R. (2020). *Literacy of Physical Education Teachers on ICT-based Instructional Media*. 1, 69–72.

<https://doi.org/10.5220/0009211900690072>

Palao, J. M., Hastie, P. A., Cruz, P. G., & Ortega, E. (2015). The impact of video technology on student performance in physical education. *Technology, Pedagogy and Education*, 24(1), 51-63.

Rodríguez Quijada, M. (2015). Information and Communication Technologies (ICT) in physical education. A theoretical review. *Sportis-scientific technical journal of school sport physical education and psychomotricity*, 1(1), 75-86.

Surahman, E., Zufar, Z., Thaariq, A., Qolbi, M., & Setiawan, A. (2020). *Investigation of the High School Teachers TPACK Competency in South Garut , West Java , Indonesia*. 501(Icet), 461–466.

Tanucan, J. C. M., Hernani, M. R. A., & Diano, F. J. (2021). Filipino physical education teachers' technological pedagogical content knowledge on remote digital teaching. *International Journal of Information and Education Technology*, 11(9), 416-423.

Tearle, P., & Golder, G. (2008). The use of ICT in the teaching and learning of physical education in compulsory education: How do we prepare the workforce of the future? *European Journal of Teacher Education*, 31(1), 55–72.
<https://doi.org/10.1080/02619760701845016>

Valtonen, T., Leppänen, U., Hyypiä, M., Sointu, E., Smits, A., & Tondeur, J. (2020). Fresh perspectives on TPACK: pre-service teachers' own appraisal of their challenging and confident TPACK areas. *Education and Information Technologies*, 25(4), 2823–2842.
<https://doi.org/10.1007/s10639-019-10092-4>

Wyant, J., & Baek, J. H. (2019). Re-thinking technology adoption in physical education. *Curriculum Studies in Health and Physical Education*, 10(1), 3-17.

UNDER PEER REVIEW