Pak. j. life soc. Sci. (2024), 22(2): 1183-1192 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2024-22.2.0082

RESEARCH ARTICLE

Technological Pedagogical Content Knowledge from the Perspective of Educational Sciences and Physical Education

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ARTICLE INFO

Received: May 20, 2024

Accepted: Aug 9, 2024

Keywords

Physical Education

Pedagogical Content Knowledge

Educational Sciences

ABSTRACT

Considering the amount of time students use technology personally and in school, effective technology integration into all areas of education is a goal in most schools. Research has shown that the more you are exposed to technology, the greater your interest in applying it. Physical education teachers have been challenged to find innovative ways to integrate technology to improve student learning. A special type of knowledge is required for integration, called technological pedagogical content knowledge. Physical education teacher education programs must effectively prepare future teachers to link discipline-specific knowledge, pedagogical skills, and technology to meet high expectations for effective technology integration in schools. The aim of this study is to determine the current situation of physical education teachers and students by discussing previous research and technological pedagogical content knowledge theories from a current perspective in order to solve the obstacles of traditional teaching, promote students' active learning, and achieve better learning effects. The conceptual methods in this study have provided models and experiences that help physical education teachers effectively teach how to appropriately integrate physical education content, technology, and instructional approaches. It is recommended that teacher training program instructors be provided with professional development programs on both technology integration in teaching and emerging technologies related to physical education and sports. Furthermore, further research is encouraged to evaluate and compare pre-service teachers' perceived and actual levels of Technological pedagogical content knowledge.

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INTRODUCTION

Technological Pedagogical Content Knowledge (TPACK) refers to educators' successful use of technology for teaching and learning objectives (Angeli & Valanides, 2009). The origin of TPACK can be traced back to Shulman's concept of pedagogical content knowledge. This concept is primarily concerned with the development of optimal teaching performances and elements (Mishra & Koehler, 2006). TPACK describes seven knowledge sub-domains. Content knowledge shows how educators comprehend pieces of evidence, organizations, and content grades. Pedagogical knowledge shows what information educators have learned about general educational values and tactics. Technological knowledge reveals educators' technological competencies. Pedagogical content knowledge (PCK) is concerned with teaching specific subjects with domain-specific educational approaches (Graham,

2011). In fact, the TPACK model (Figure 1) considers the complex relationship between the three characteristics (Chai et al., 2013).

Content knowledge is an indicator of how teachers perceive pieces of evidence, organization, and content level (Koh and Chai, 2016). This concept is related to topics, features or characteristics and practices with different standards. Given these conditions, employees working in educational institutions need to implement or apply different techniques in the context of teaching and learning.

Pedagogical knowledge deals with various techniques, educational approaches, and learning procedures, as well as learning success in education (Archambault and Barnett, 2010). In the broader context of TPACK, pedagogical knowledge also refers to the execution of lesson preparation and planning processes, effective management of educational resources, and also the assessment of learners. Technology knowledge allows educators to foresee examples where technology can be effectively integrated into their education (e.g., computer simulations). Such knowledge shows that technology and material affect and support each other. Therefore, educators need to be aware of both their own material fields and the use of specific technologies that enhance students' learning. This knowledge requires educators to understand that using certain technologies can change the way concepts in a particular material are understood. This type of knowledge also consists of the ability to use certain technologies in educational procedures (Mishra and Koehler, 2008). Many educators have resisted integrating technology into their classrooms due to the failure of professional development programs to provide the necessary competencies and knowledge to effectively integrate technology into their classrooms. Therefore, in pre-service professional development classes, the development of TPACK seems to be very important, considering the fact that TPACK is an important structure that can enhance the training of educators in an Internet-based classroom (Hughes and Scharber, 2008). It is thought that pre-service teachers generally use technology for easy tasks such as sending e-mails and making presentations rather than for educational purposes. Therefore, technological integration should be taken into consideration in educator training programs. Integrating a learning control system into educational activities requires both specific technical knowledge and new educational knowledge (Ouadoud et al., 2018). As a result, designing and developing educators' TPACK is important before integrating certain technologies for learning.

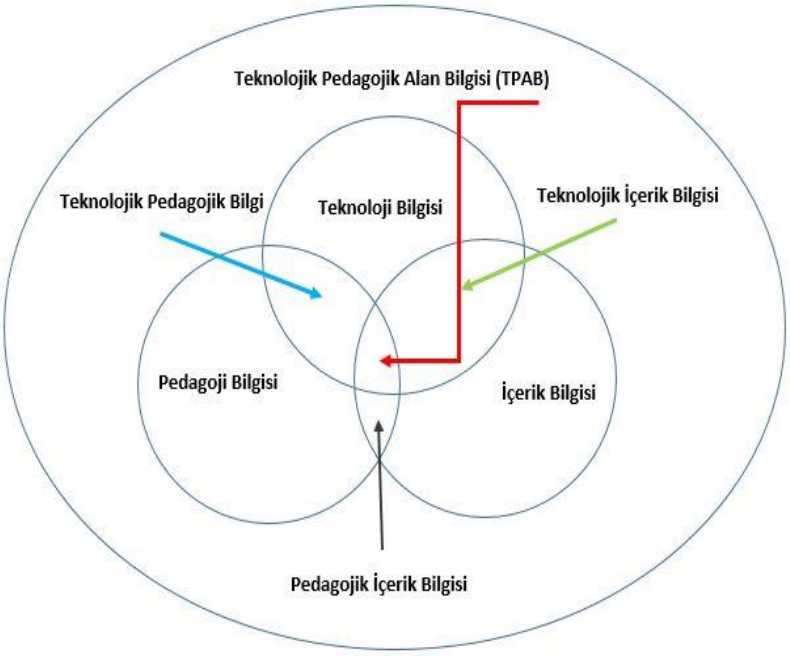

Figure 1: TPAB model

Because physical education is often taught in a gym or outdoors, it is important that physical education teacher education programs prepare teachers to incorporate technology in ways that support the pedagogical strategies used in these settings. Teachers need to learn and practice teaching skills in a context that is as similar as possible to the one they will later teach. For example, use of exercise equipment to assess physical activity (e.g., accelerometers, iPads, heart rate monitors, pedometers, interactive dance machines), body composition (e.g., bioelectrical impedance devices, electronic skinfold calipers), and use of video analysis equipment to analyze movement and motor skill performance (Huban Çebi & Yamak, 2021; Makaracı et al., 2023; Şirin & Ünlü 2024).

Physical education programs need to integrate technology, and physical educators need to think creatively using TPACK for opportunities to integrate technology to create enriching learning experiences for their students (Pyle & Esslinger, 2014; Çimen, 2022).

Studies have shown that physical education teacher candidates have a positive attitude towards technology (Gotkas, 2012) and the more they are exposed to technology, the more they tend to apply it (Clapham, Sullivan, & Ciccomascolo, 2015). The purpose of this study is to determine the current situation of physical education teachers and students by discussing previous research and technological pedagogical content knowledge theories from a current perspective in order to solve the obstacles of traditional teaching, encourage students' active learning, and achieve better learning effects.

CONCEPTUAL FRAMEWORK

Content knowledge (CK) or Knowledge of the subject to be studied. The material is included in the curriculum. For high school students studying chemistry, physics, biology, and mathematics, the subject boundaries of the curriculum need to be interpreted holistically. Shulman (1986) stated that the subject includes knowledge in the form of concepts, theories, ideas, frameworks, methods

supported by scientific methods, and their application in daily life. Some examples include acid-base concepts, theory, natural indicators, acid-base indicators, solution pH, and acid or base ionization constants.

Teaching physical education effectively is an extraordinarily complex task; it requires a deep understanding of the characteristics of the students being taught, how learning occurs, the content to be taught, differentiated pedagogy, and curriculum (Shulman, 1986). One of the most useful concepts for examining teaching practice is pedagogical content knowledge. CK is the transformation of content (e.g., a serve in tennis) into a form that helps students learn and understand (e.g., using a ball suspended by a stick to the right and overhead to show the student the point of contact during the serve). The concept of CK, which is accepted as a blend of four knowledge bases, consists of (a) knowledge about the goals and objectives of instruction, (b) knowledge about students' understanding of the subject matter, (c) knowledge of curriculum and resources, and (d) knowledge about representations and teaching strategies. Recently, CK has been conceptualized in terms of content and student knowledge, content and instructional knowledge, and curriculum knowledge (Ball, Thames, & Phelps, 2008).

Pedagogical knowledge (PK) refers to in-depth knowledge of teaching and learning theory and practice, such as CK, objectives, processes, assessment learning methods, strategies, etc. Pedagogical knowledge, on the other hand, requires an understanding of cognitive, affective, and social aspects as well as development. Learning theory and its application in the learning process. Teachers should thoroughly understand and focus on the required pedagogy, especially how students understand and construct knowledge, attitudes, and skills (Koehler et al., 2011). Examples: constructivism, scientific and discovery learning, problem-based learning, guided inquiry, question-answer, discussion, presentation, observation, and practice. Recently, the examination of CK and CK in physical education from a behaviorist perspective has highlighted an often neglected part of CK for prospective teachers and physical education teachers (Ball, Thames, & Phelps, 2008).

Technology knowledge (TK) shows the basics of technology that can be used to support learning. Examples include software, animation programs, internet access, molecular models, virtual laboratories, and other technologies. As a result, teachers need to be experts in computing in the classroom. Mishra et al., (2006) emphasize the importance of basic knowledge, technological knowledge, and the ability to apply them to support understanding of the subject being studied. Also, mastering this technology is a necessity for students in the twenty-first century (Jordan, K. 2011). Examples: google Drive, OneNote, ChemDraw, chem Sketch, Prezzi, Edmodo, Youtube, Ulead, Windows movie maker, Avidemux, jmol, hyperchem, chemtool, bkchem, Lectora, moodle, Dokeos, ATutor, internet, laptop, LCD, video, socket.

It is important to understand that technologies have certain capabilities and limitations (Koehler & Mishra, 2008). The function of the technology depends on the domain in which it is used and should be considered in this context. For example, the purpose of a tool such as a spreadsheet is to provide basic database functionality as well as spreadsheet and calculation functions for financial uses. It can also be used in education for analysis and problem-solving activities as a cognitive tool for processing statistical data (Jonassen, 2000). Physical education teachers can use this tool to collect data and track their students' progress on individual fitness exercises such as mileage runs, sit-ups, sit-and-reach tests, and push-ups. After the test is completed, students can view their personal data and use the statistical functions of the spreadsheet graphs to see their individual progress. Other technologies and collaboration tools such as online file sharing, discussion boards, chat logs can facilitate teamwork and group learning and allow the teacher to evaluate individual contributions and team

functioning (Barcelona & Rockey, 2010). Thus, the creative use of certain technologies allows educators to repurpose existing tools for pedagogical purposes (Koehler and Mishra).

Pedagogy content knowledge (PCK) covers the interactions and intersections between pedagogy and content. It includes the learning process and student assessment system for the subject being studied. The learning model is expected to provide the participants with the necessary tools to learn effectively, and it is necessary to understand the relationship and intersection of pedagogy and content, and to focus on how pedagogy can affect the content. According to Koehler, PCK is a body of knowledge and a course of study. It covers general pedagogy, knowledge transformation, and learning strategies in educational contexts (Mishra, P. and Koehler, M. J. 2006). Examples include discovery learning and constructivism as strategies for learning acid-base concepts, guided inquiry as a strategy for learning natural indicators, and student discussions on acid-base concept material in daily life.

Physical education teachers are professionals in at least two areas: they are both professionals in the field of sports science and professional teachers. In contrast, sports science students who do not aim for a teaching degree are professionals only in the field of sports science. Second, they are professionals because they are experts in the subject. However, to our knowledge, there is no study investigating whether there are differences in the PCK of students aiming for a teaching degree in sports science. Regarding noticing, a construct close to PCK, Reuker (2017) investigated differences between groups with different expertise (i.e. athletes versus teachers). The findings suggest a connection between pedagogical expertise and a focus on teaching aspects. In particular, physical education teachers with a high level of pedagogical expertise mention methodological and didactic approaches more frequently than athletes with only a high level of sport-specific expertise (Reuker, 2018). Therefore, it can be assumed that there are differences in PCK between subject experts and teachers. Academics in other fields have reported higher PCK scores than teachers (Jüttner and Neuhaus, 2013). However, a comparison between pre-service teachers and students majoring in mathematics showed that the pre-service teachers' advantage in PCK can be attributed primarily to the "teaching" dimension (Krauss et al., 2008).

Technology Content Knowledge (TCK) involves understanding technology and subject matter that can assist and impact other components (Mishra, P., & Koehler, M. J. 2006). Examples include using Google Drive to store student worksheets, using Prezzi and YouTube to learn acid-base indicators, and using Edmodo to submit assignments on pH questions related to strong acid and strong base solutions.

Technology pedagogical knowledge (TPK) is a set of understandings about how learning changes occur when technology supports active learning and helps simplify subject concepts. TPB requires an understanding of the benefits and drawbacks of the technology involved when applied to the context of the subject matter encountered in the learning process (Schmidt et al., 2009). For example, using Prezzi and YouTube to facilitate guided inquiry in discussing acid-base indicators or using Google Drive in conjunction with student worksheets to support Discovery Learning in investigating natural indicators.

Technology pedagogy content knowledge (TPACK) is a learning series in which the ability to master technology is integrated and cannot be separated from the components that constitute it. Multiple interactions and combinations of components, including subject, pedagogy, and technology, are required for TPACK. According to Mishra and Koehler (2006), the concept of integration is the inclusion of various materials and pedagogy areas/components that can assist teachers. For example, Prezzi and YouTube can help students understand acid-base indicator material with guided

questioning strategies, while Google Drive, which includes student worksheets with a discovery learning strategy, can help students discover and analyze natural indicators.

The TPACK model suggests that the technology used should work together with pedagogical knowledge and content-specific knowledge to enhance instruction and be appropriate for the characteristics of students and the learning environment (Koehler and Mishra, 2008). Contextual factors in physical education can create challenges for physical educators when integrating technology (Roth, 2014). Here, there are contextual factors inherent in teaching physical education, such as not always having access to a power source or Wi-Fi, especially if physical educators are teaching outside or in a gym, which can limit integration opportunities and methods. Security of devices can also be an issue given the nature of how lessons are designed and the dynamic environment of physical education. These factors need to be addressed appropriately.

DISCUSSION

At present, the majority of physical education teachers still adopt the traditional didactic teaching approach in their classrooms. Teachers demonstrate and explain movements, and students tend to follow blindly, which leads to difficulties in improving the quality of physical education (Xie, 2020; Zeller, 2017). This teacher-centered learning approach transfers knowledge according to a top-down model and requires students to acquire physical skills through imitation and repeated practice. Although such a learning mode can help students successfully acquire physical skills, students tend to rely on teachers' instructions and demonstrations and practice without reflection and deep thinking, which may reduce their enthusiasm and commitment to learning (Xie, 2020). However, there is a close relationship between the thirst for active knowledge acquisition and learning performance. Some researchers have stated that students who use self-regulated learning strategies in physical education can better develop their knowledge and physical skills (Behzadnia et al., 2019). In terms of the field of practice-based learning, compared to notes and written comments, video feedback can provide more information to facilitate students' understanding of knowledge and strengthen the connection between theory and practice (Brown and Fridman, 2020). For example, recording novice teachers' teaching lessons allows them to observe field activities from the perspective of spectators and reflect on their teaching performance to improve or modify teaching strategies (Sööt and Anttila, 2018). This approach, which allows individuals to reflect on their own post-practice performance by reviewing their own recordings, has also aroused great interest in the field of motor skill learning. Especially with the widespread use of video recording and viewing functions on tablet computers, the adoption of this approach through reflection via video feedback has become more immediate, convenient, and natural in physical education (Lin et al., 2020). Numerous studies have indicated that learning gymnastics, swimming, dance, or badminton with this approach can help students have better physical skill performance than traditional teaching (Hung et al., 2018; Lin et al., 2019).

Ball et al., (2008) divided CK into two broad areas: (a) common content knowledge, which refers to the knowledge and skills one needs to perform a task, such as using the correct technique to perform a layup in basketball. (b) specific content knowledge, which refers to the knowledge and skills representing how to teach a layup in basketball (Ward, 2009), defined common content knowledge as knowledge of rules and etiquette, technical and tactical knowledge, and specific content knowledge as knowledge of student errors, and knowledge of teaching tasks and representations. In short, specific content knowledge is the form of CK that represents a teacher's understanding of the tasks that can be used to teach common content knowledge. To go into more detail, consider a textbook explaining the sequence of tasks for teaching the front crawl in swimming. This represents common content knowledge (e.g., stroke technique) and specific content knowledge (e.g.,

instructional tasks). The description is all about the content. A teacher who studies this content and prepares to teach beginners will choose very different tasks than one who prepares to teach more advanced students. In both cases, the teacher will use information outside of the content when making decisions about what content to teach, such as the students' abilities and learning characteristics, the space in the pool, the equipment, and the pedagogy to be used.

Previous research has shown that preservice physical education teachers have a positive attitude toward technology and that teachers develop a greater interest in using technology when they receive training (Brown & Fridman, 2020). Therefore, physical education curriculums need to develop this motivation and encourage learning experiences to grow.

RESULTS

In order to solve the obstacles of traditional teaching, promote students' active learning, and achieve better learning effects, this study refers to previous research and the educational theory of reflective practice.

First of all, emphasis should be placed on the information technology training of physical education teachers. Therefore, physical education teachers should be encouraged to use information technology in their daily lives, improve their information technology abilities, and guide physical education teachers to think more about how to use it daily. Teaching knowledge, subject knowledge, and subject teaching knowledge are realized.

Secondly, the cultivation of subject teaching knowledge of physical education teachers should be strengthened. The physical education curriculum has its own unique characteristics. At the same time, physical education teachers with rich teaching experience should focus on improving their information literacy and the ability to integrate information technology into teaching, because when they have technical knowledge, they will be more likely to achieve effective integration of information technology and physical teaching.

Third, the information literacy of regular students majoring in physical education should be strengthened. At the pre-employment training stage, attention should be paid to the transfer of technical knowledge, subject knowledge, and teaching knowledge to lay a solid foundation.

Fourth, physical education teachers should be encouraged to improve their academic qualifications after they enter the job. From a general perspective, the TPACK of physical education teachers with higher academic qualifications is higher than that of physical education teachers with relatively lower academic qualifications. Improving the academic qualifications of physical education teachers is an integral part of professional development. Regardless of the initial academic qualifications, teachers who are committed to personal professional development through learning are better able to accept new things and new technologies. These advantages should be used to improve academic qualifications.

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