

Challenges to the pre-service teachers and enabling their TPACK knowledge during B.Ed. degree program of AIOU, Pakistan

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Abstract:

Every program that trains future teachers is different with its own techniques for assisting pre-service teachers in developing their TPACK (technological pedagogical content knowledge) knowledge and skills. Present study assessed pre-service teachers' professional knowledge and teaching abilities in relation to the AIOU B.Ed. (1.5-year) degrees that they had earned. According to the findings of the survey, student-teachers who intended to pursue careers in the field of mathematics showed the lowest mean regarding their levels of pedagogical ability. The student-teachers in the reading domain, however, obtained the highest mean score for pedagogical expertise out of all five participant groups. This was due to the fact that they had the most experience teaching staff. Students who were planning as English teachers had the lowest mean ratings for their technological ability. The evaluation of teachers' perceptions of their understanding of the TPACK's components found that the PK (pedagogical knowledge) and PCK (pedagogical content knowledge) performed the best overall of all the components. Interviews with the twenty future teachers elicit their perspectives and challenges in the teaching profession. Pre-service teachers do not obtain an adequate amount of technical education training during B.Ed program. They had very low experience regarding technology-integrated teaching and learning.

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1. Introduction

Teachers today are expected to not only know the scientific content they teach but also to have a firm grasp of the pedagogical ideas and classroom strategies that underpin it. Teachers are also expected to effectively utilize technological tools in the classroom (Asad *et al.*, 2020; Ghavifekr & Rosdy, 2015). However, not all teachers have a firm grasp on how to use and integrate technology into their lessons effectively. Given this fact, it seems to make sense to require teachers to take technology classes as part of their professional development (Polly & Martin, 2020). Allama Iqbal Open University is recognized public organization to provide remote education through Pakistan, teacher educators of this university believe that it is essential for pre-service teachers to learn cutting-edge lesson plans and keep up with technological advancements so that, in the future, they will be influenced to incorporate technological innovations into their own classrooms. Professors in this division integrate technology into their lessons by means of the TPACK model (Technological, Pedagogical and Content Knowledge). The use of computers in educational institutions is now commonplace. Although computers are widely available and inexpensive, they are nevertheless underutilized in the classroom (Daniels, 2002; Cradler *et al.*, 2002). It would appear that educators are unable to effectively integrate technology into their lesson plans as it stands (Brand, 1997).

Examining the causes of teachers' knowledge gaps, numerous studies have found that teaching technological skills in isolation and as separate talents in teacher education programs is insufficient to prepare instructors to use technology in the classroom (Vrasidas & McIsaac, 2001; Flick & Bell, 2000; Koehler *et al.*, 2007). It is becoming increasingly important to teach how to integrate technology into classroom instruction rather than teach computer skills in isolation from subject matter (Silverstein *et al.*, 2000; Sandholtz, 1997). There have been a number of studies that indicate that modifying curricula and pedagogical approaches is essential to successful technology integration (Lee, 2002; Vrasidas & McIsaac, 2001; White *et al.*, 2002). TPACK framework has received a lot of attention from academics and classroom teachers alike. Almost 600 TPACK-related articles were added to Scopus between 2011 and 2019 (Tseng *et al.*, 2020). Many of these studies focus on generic TPACK rather than domain specific TPACK. Roughly 51 works on language instruction can be found in the Web of Science and Scopus databases. The majority of these articles explore educators' perspectives on TPACK (Tseng *et al.*, 2020).

1.1. Assessment of pre-service teachers' TPACK framework

TPACK framework can help teachers understand how technology can be effectively integrated into the classroom (Koehler & Mishra, 2009; Shulman, 1986). The seven knowledge forms that make up the TPACK structure include three main forms of knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technical Knowledge (TK), and three derived forms of knowledge: Pedagogical Content Knowledge (PCK), Technical Content Knowledge (TCK), and Technical Pedagogical Knowledge (TPK) (Mishra & Koehler, 2006). Extensive work has

been done to evaluate TPACK, primarily using questionnaires, interviews, observations, and performance evaluations. Of these strategies, surveys are the most common research method (Koehler *et al.*, 2012). TPACK was assessed on 124 US pre-service PK–6 teachers using a questionnaire developed by Schmidt *et al.* (2009). It has been widely used in surveys. The knowledge factor is the highest, while TK and PCK are the two lowest knowledge factors. A strong correlation was found between TPACK and the six subscales. TPACK, TPK, and PCK had the strongest correlations among all three sets of knowledge (Schmidt *et al.*, 2009).

Schmidt *et al.* (2009) examined TPACK for preservice teachers in several subsequent studies (Chai *et al.*, 2013; Dong *et al.*, 2015; Koh *et al.*, 2010; Xiong *et al.*, 2022). Koh *et al.* (2010) examined the TPACK of 1,185 pre-service teachers in Singapore. Analysis of the data led to the identification of five distinct structures: CK, TK, KP (Knowledge in Pedagogy), KTT (Knowledge in Teaching using Technology), and KCR (Knowledge from Critical Reflection). Because the participants cannot tell the difference between the items in the constructed TPK, TCK, and TPACK, they are all loaded as KTT. Chai *et al.* (2010) evaluated the TPACK growth of 889 pre-service teachers in Singapore. They found that the most significant effect on the teaching ability of these teachers was PK, which had an effect on all three components of their TPACK. The participants had the lowest perceptions of TK before and after Information and Communication Technologies (ICT) training. Chai *et al.* (2011) also studied TPACK development in 834 Singaporean pre-service teachers. The study found that both TK and TPK significantly and positively predicted TPACK in both the pre- and post-class models.

According to the Education Policy 1972–1980 (pp. 34–35), the educational needs of teachers must be met “by changing teacher education programmes and implementing new technologies to meet the broad requirements of teachers at all levels.” All teacher training programmes should also be reformed and restructured. Changing the elementary and high school curriculum is just the beginning. Allama Iqbal Open University's teacher training programme uses a cutting-edge distance learning approach. National Education Policy of 1979 states that “teachers are the core of the entire education system, and it is recommended that the government increase teacher development programs.” Under the new policy, all normal schools and colleges that train primary school teachers have been upgraded to primary education colleges. Some of the objectives for teacher development are listed on pages 47-54 of the National Education Policy 1998–2010. One of the goals is to achieve a healthy balance between teacher supply and demand.

1.2. Relationships between demographic variables and teachers' TPACK

Background characteristics, such as gender, age, teaching level, and years of experience, may have an impact on instructors' TPACK. TK, TCK and TPACK have been found to have lower levels of confidence in female teachers than in male teachers, but greater levels of PK (Lin *et al.*, 2013) or CK in male teachers (Cheng, 2017; Koh *et al.*, 2014). According to professors' research Jang and Chang (2016), there were no statistically significant variations in overall

TPACK between men and women. A teacher's age and teaching experience may also have an impact on their understanding of TPACK. According to a previous study, teachers who are older and more experienced tend to rate technological concepts lower than those who are younger and less experienced (Lee & Tsai, 2010; Yaghi, 2001). CK and PK scores are more likely to be higher in teachers with greater levels of experience (Jang & Chang, 2016). According to Lee and Tsai (2010), more experienced teachers lacked competency in using and integrating digital technologies into the classroom, according to their findings. In Cheng's (2017) study, there was no correlation between the participants' TPACK and their age. Additional research found that older female teachers in TK were less secure than their younger counterparts. In addition, those with more classroom experience exhibited stronger confidence in CK, PK, and PCK than the others.

2. TPACK framework

The original intention behind the development of the TPACK framework was to provide educators with a conceptual framework that would assist them in effectively incorporating technology into their teaching. In a number of these investigations, TPACK has been applied as a quantitative measurement (Cavanagh & Koehler, 2013). In addition, a number of studies have used the TPACK framework in qualitative designs in order to acquire a comprehensive comprehension of the ways in which the TPACK domains and technology interact with one another (Cox & Graham, 2009). When using TPACK as a measurement instrument, it is advised by Abbitt (2011) that norms be developed for the various TPACK levels. The following studies provide evidence that lends credence to both the practical applicability of the TPACK framework and the reliability of the TPACK survey.

Koh (2019) carried out research on the utilization of TPACK design scaffolding in order to support the pedagogical reform of teachers while he was enrolled in a graduate course for an educational technology program. In a survey given both before and after the course, 47 educators said that the influence of scaffolding TPACK design through a learning rubric, lesson design, and TPACK activity type had the effect of increasing their level of confidence. The TPACK framework, which was developed by Mishra and Koehler (2006), was utilized in order to gain a deeper understanding of how pedagogical innovation in ICT in lessons induced a change from teacher-centred to student-centred instruction (Koh, 2019). The TPACK framework and the ICT integrated lessons that were prepared with specific content and pedagogical methodologies gave teachers the opportunity to synthesize the interactions between the knowledge in various fields.

Based on the literature reviewed, the study would like to investigate the questions as: a) to what extent does the B.Ed. (1.5-year) program of Allama Iqbal Open University (AIOU), Islamabad, Pakistan equipped the pre-service teachers with Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK); and b) what the challenges are faced by the institution in developing the pre-service teachers' TPACK in terms of TK, PK and CK.

3. Research methodology

The researchers used a Single Embedded Case Study. According to Creswell (2003), a case study allows researchers to explore in-depth topics while gathering data through more than one resource. The researchers also collected data through multiple sources, for instance, questionnaires, interviews, and document analysis. The single embedded case study was used in this study to improve quality and bring improvement in the B.Ed (1.5-years) elementary program in the department of education at AIOU. According to Yin (2013), an embedded case study is a case study containing more than one sub-unit of analysis. The unit of analysis of this study was the Education Department of AIOU, and the subunit of analysis was pre-service teachers, because the researchers wanted to explore the knowledge and understanding of pre-service teachers about TPACK in a 1.5-year B.Ed program. According to Yin (2009), a mixed-method approach can be used in a single case study research. Therefore, within this single embedded case study, an exploratory sequential mixed method was used by the researchers.

According to Creswell (2003), in an exploratory sequential procedure, first qualitative data is gathered and then qualitative data guides were used by the researchers towards quantitative data. The purpose of selecting the exploratory sequential mix method was to triangulate the obtained data through different resources for the purpose of triangulation. Based on Mishra and Koehler (2006) TPACK paradigm for integrating technology into education and the theme of “survey of pre-service teachers' knowledge of teaching and technology” the instrument was built (Schmidt *et al.*, 2009). After the survey was approved, alterations were made. A Cronbach's alpha score of 0.895 indicated that the survey's internal consistency was strong. All seven constructs were represented by seven questions on the questionnaire, which included six questions on TK; six questions on pedagogical know-how; three questions on content know-how; eight questions on technological pedagogy; and six questions on technological CK. The study's participants were 110 future teachers who were enrolled in a 1.5-year AIOU for B.Ed. program. There were 52 female and 58 male future instructors enrolled in the program. Purposeful sampling was used to acquire data from pre-service teachers in the education department.

Table-1: Demographic profile

Description	Unit	No. of Units
Gender	Male	58
	Female	52
Pre-service teachers	1 st semester	30
	Second semester	40
	Third semester	40

4. Data analysis

Descriptive statistics were used to analyze the TPACK survey. There were six categories in the questionnaire and the researchers explained each category in detail according to the responses

by calculating mean score of each category with the help of SPSS in tabulated form. The cut point of the mean score was three. The purpose of selecting the cut point three was that because the mean score of most of the item of each category was above than three. According to Greene (2007), for the triangulation purpose, the quantitative and qualitative data has been presented separately.

According to table-2, the vast majority of future teachers indicated the least amount of positive and the least level of pleasure regarding their TK when responding to the broad category of TPACK. According to the mean score of three, the pre-service teachers are knowledgeable of and have experience with the general category of TK. Pre-service teachers who have a familiarity and knowledge of the practical use of technology that is less than three points above the mean have only a cursory understanding of the topic. It was determined that the academics had a lower level of real-world competence due to the fact that the average score for technical problem-solving abilities was 1.47.

Table-2: Pre-service teachers TPACK analysis

Technology Knowledge (TK)	N	Mean(std)
1. I know how to solve my own technical problems.	110	1.47 (.502)
2. I can learn technology easily.	110	3.42(.827)
3. I keep up with important new technologies.	110	3.02(.867)
4. I frequently play around the technology.	110	3.11(.902)
5. I know about a lot of different technologies.	110	2.82(.950)
6. I have the technical skills I need to use technology.	110	3.00(.967)

According to table-3, the vast majority of aspiring educators have an inadequate grasp of the subject matter in mathematics. They exhibited their expertise in mathematics and their ability to develop new approaches to teaching methods of mathematics. The pre-service teachers have given themselves ratings that are all higher than three, which indicates that they are pleased with both their degree of mathematics knowledge and their capacity to put that knowledge into practice.

Table-3: Pre-service teachers TPACK survey

Content Knowledge (CK) Mathematics	N	Mean(std)
7. I have sufficient knowledge about mathematics.	110	3.00(.967)
8. I can use a mathematical way of thinking.	110	3.42(.827)
9. I have various ways and strategies of developing my understanding of mathematics.	110	3.11(.902)

In table-4 the mean scores of the pre-service teachers regarding subject knowledge was calculated. Results indicated that pre-service teachers have insufficient knowledge of social studies. It was also observed that pre-service teachers do not possess an adequate knowledge of science, as evidenced by the fact that the majority of teachers received scores lower than three for their science knowledge. As a result of their lack of understanding of how scientific thought works, they are unable to improve my understanding of science by employing a variety of scientific procedures and approaches. Literacy received an average score of three out of five

possible points, showing that prospective educators have a sufficient comprehension of literacy. My reading comprehension has been significantly improved as a result of the pre-service teachers' familiarity with the literary mode of thought and their wide range of strategies and tactics. In terms of PK, the majority of future teachers have scores of three or higher, which indicates that they are able to evaluate the academic achievement of their pupils in the classroom. Pre-service teachers are able to adapt my method of instruction to meet the requirements of a wide range of students because they are familiar with the misunderstandings and conceptual gaps that exist among their future pupils.

Table-4: TPACK survey

Knowledge of subjects	N	Mean(std)
Social Studies: 10. I have sufficient knowledge about social studies.	110	2.18(.545)
Science: 11. I have sufficient knowledge about science. 12. I can use a scientific way of thinking. 13. I have various ways and strategies of developing my understanding of science.	110 110 110	3.09(1.216) 2.82(.950) 2.83(.977)
Literacy: 14. I have sufficient knowledge about literacy. 15. I can use a literary way of thinking. 16. I have various ways and strategies of developing my understanding of literacy.	110 110 110	3.00(.977) 3.21(1.166) 3.21(1.166)
PK (Pedagogical Knowledge): 17. I know how to assess student performance in a classroom. 18. I can adapt my teaching based -upon what students currently understand or do not understand. 19. I can adapt my teaching style to different learners. 20. I can assess student learning in multiple ways. 21. I can use a wide range of teaching approaches in a classroom setting. 22. I am familiar with common student understandings and misconceptions.	110 110 110 110 110 110	3.21(1.166) 2.83(.977) 3.09(1.216) 3.21(1.166) 3.42(.828) 3.21(1.166)

Table-5 contains a listing of the pre-service teachers' levels of comprehension of pedagogical content, as well as their utilization of effective teaching approaches and the number of students who scored a three for how well they responded to their instruction in mathematics. If pre-service teachers earn a score that is lower than three, this shows that they have only a fundamental comprehension of the specific subject they will be teaching and the instructional methods associated with it.

Table-5: Pre-service teachers TPACK analysis

Pedagogical Content Knowledge (PCK)	N	Mean(std)
23. I can select effective teaching approaches to guide student thinking and learning in mathematics.	110	3.00(.967)
24. I can select effective teaching approaches to guide student thinking and learning in all subjects.	110	2.18(.545)

Table-6 is a description of the level of technology content comprehension possessed by pre-service teachers. If the students' mean score is lower than three, it indicates that they have a negative attitude toward the use of technology in the classroom to teach a certain subject. Pre-service teachers get a score of 2.67 if they are knowledgeable about the technologies they can use to comprehend and complete tasks in math and social studies, while those who utilize the same technologies to comprehend and complete assignments in science and literacy get a score of 2.18.

Table-6: Pre-service teachers TPACK analysis

TCK (Technological Content Knowledge)	N	Mean(std)
25. I know about technologies that I can use for understanding and doing mathematics and social studies.	110	2.67(.900)
26. I know about technologies that I can use for understanding and doing literacy and science.	110	2.18(.545)

The pre-service teachers' technological and pedagogical competence is summarized in table-7, which may be found here. The vast majority of pre-service teachers who earned scores lower than three on the mean test show that they do not have the knowledge essential to select technologies that will improve their teaching tactics for a lesson as well as their students' learning. However, pre-service teachers gave the teaching program a score of three, which suggests that the program prompted them to think more carefully about the ways in which technology might alter the instructional practices they deploy in the classroom. The use of innovative instructional tools in the pre-service teachers' coursework is met with positive feedback from those students.

Table-7: Pre-service teachers TPACK analysis

Technological Pedagogical Knowledge (TPK)	N	Mean(std)
27. I can choose technologies that enhance the teaching approaches for a lesson.	110	2.67(.900)
	110	3.00(.967)
28. I can choose technologies that enhance students' learning for a lesson.	110	3.00(.967)
29. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.	110	2.18(.545)
	110	3.11(.902)
30. I am thinking critically about how to use technology in my classroom.	110	2.67(.900)
31. I can adapt the use of the technologies that I am learning about to different teaching activities.	110	3.00(.967)
32. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.	110	3.00(.967)
33. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.		
34. I can choose technologies that enhance the content for a lesson.		

There are two key practical repercussions that can be drawn from the study. The first implication has to do with an update to the curriculum that is currently being used for pre-

service teacher training. It is essential that pre-service teachers have improved support for TPACK as part of their preparation to become teachers. Studies conducted in the past have indicated that pre-service teachers' TPACK can be improved by the use of ICT training programs (Chai *et al.*, 2010). The standards for teachers do not prescribe any specific courses on educational technology. However, they do state that teachers should demonstrate the knowledge and aptitude necessary to apply contemporary educational technologies in the classroom. These standards may be found here (Hanban, 2015).

5. Qualitative analysis of interviews of prospective teachers

Pre-service teachers were interviewed using a semi-structured interviewing process to learn about their Technological and Pedagogical Content Knowledge Practices (TPCKP), Technological Knowledge Practices (TKP), Technological Pedagogical Knowledge Practices (TPKP), Technological Content Knowledge Practices (TCKP) and finally, the challenges they face when incorporating digital technology into the classroom. Twenty prospective teachers were interviewed. Potential instructors' replies were analyzed in the tables below according to the topic and its subthemes.

5.1. Course burden

According to pre-service teachers, three out of four ICT-related courses could not be completed. A large amount of material was cited as a reason why they couldn't complete the ICT-related courses in the time frame given. It is difficult to find qualified ICT instructors because of a lack of time, a lack of technological experience, and a lack of interest on their part. Even though the books have all the material about introduction to computers in the first semester, we are still not very familiar with the use of ICT because we lack practical experience, and we think that is the main reason that creates difficulty in covering the course material. To add insult to injury, "the course of ICT in education contains a great deal of material" they said. As a result, we focus solely on studying to pass the exam.

5.2. Considerations for pre-service teachers for teaching ICT-related courses

Computer lab teaching of ICT-related courses to aspiring teachers was voted the most popular choice by the four respondents. According to the Department of Educational Development, computer laboratories are necessary to support effective ICT activities in schools. Respondent "I truly feel that this course should be taught in a computer lab, and it is the education department's responsibility to provide lab equipment for higher chances." As a result, books and online courses were not very helpful in teaching this topic. Other respondents said that ICT courses should be taught in computer labs and that the labs should be equipped with the essential ICT resources. Recommendations from pre-service teachers on how to ensure a steady supply of qualified educators Two-thirds of those polled believe that aspiring teachers should attend courses in ICT from more experienced professors. They argued that there should be two

teachers teaching ICT-related courses to aspiring teachers simultaneously. One should be an expert in computers and the other in educational technology.

5.3. The challenges faced by prospective teachers

Pre-service teachers do not have any access to new Technologies especially in remote areas. Moreover, potential teachers were dissatisfied with the available technological resources. Computer laboratories, interactive whiteboards, and educational software are allegedly non-existent, according to this group. Among the difficulties they cited were the following: The lack of computer labs meant that our focus was primarily theoretical. It is critical that future teachers be able to practice their teaching skills in modern labs equipped with the latest in information and communications technology. Another teacher claimed that “even pre-service instructors have not seen an interactive whiteboard. We are having significant difficulties due to a lack of instructional technology and software.” If they are not introduced to current instructional technological resources, pre-service teachers will face several difficulties in the classroom. Dearth also has its own research facilities. Every now and then, there is no electricity. We have a lot of issues with a light that switches between on and off. The use of the Internet is not commonplace. There is a long pause between each step. Teachers demonstrate their own biases in this regard. Future educators offer suggestions about how to make things better.

Another aspiring instructor stated that he needed more time to completely study the subject topic before generating the teaching materials. CK and TCK issues arose while he was working on the materials, which were tough for him to overcome. To keep the class interested, he needed to come up with new ideas. He emphasized that the problem is not with the technology. However, the problem here is one of innovation. In order to be more creative is a challenge. Even when the concept is present, it is difficult to make the design compelling. A lack of interest on the part of students will swiftly lead to a loss of respect for the material. It's time to get creative if we want to keep students interested in their studies.

5.4. ICT Integration in the program

Five of the twelve respondents questioned felt that the courses were insufficient to satisfy the technological demands of the 21st century. In contrast, two of the three respondents had taken both the ICT course and the other (ICT and Educational Technology). They suggested adding a few more courses to improve the program. To better train future teachers and meet worldwide standards, four out of the twelve respondents asked that the current curricula be changed. Two respondents noted that pre-service instructors should be highly skilled and experienced in order to appropriately teach ICT courses. Pre-service teachers in the computer science department are said to be more reluctant to use ICT tools in the classroom, even though they have a working knowledge of computers. According to them, pre-service teachers who teach ICT should have

both technological and academic training. He or she must be well-versed in educational technology to be of any use to you.

6. Conclusion

When the scores on the TPCK components of all of the participants in the various fields were compared, it was obvious that the student-teachers in the domains of social studies and science had the lowest mean scores in every TPCK component, with the exception of pedagogical knowledge. The student-teachers who were going to work in the field of mathematics had the lowest mean score when it came to their pedagogical knowledge. The student-teachers in the domain of literacy, however, got the highest mean score for pedagogical expertise out of the five different participant groups. The students who were studying to become English instructors had the lowest mean ratings for their technological expertise. The results showed that the PK and PCK did the best overall in the test of perceived grasp of the TPCK's components. This was the case across the board. The results of the current research indicated that, despite the efforts of programs that prepare teachers, the participants' knowledge of using technology for educational purposes was inadequate (TPK). The authors of the study hypothesize that this could be because of the solitary nature of the usage of technology in teacher development programs. While it would appear that teacher education programs are making progress in successfully preparing teachers to use technology in the classroom, it would appear that they are still making slow progress in providing teachers with the specialized knowledge required to use technology in the classroom in an efficient manner.

Education for teachers should not be restricted to the minimal technologies required to meet demand, as shown in this study. They should include technology in their teaching approaches in all classes. Soomro *et al.*, 2018 found that instructors' attitudes toward TPACK were strong, as were their evaluations of their TPACK skills. According to the authors, pre-service teachers should also take courses in technology, content, and pedagogy in addition to their selected subject area. Our research also came up with a similar conclusion. According to another study (Tyarakanita, 2020), pedagogical, material and technical abilities should all be taught and practiced together in tandem. Pre-service teachers did not obtain adequate training in technical education during their academic studies at colleges of education. A more realistic approach to managing resources other than people and human power is required for effectiveness and efficiency. According to Koehler and Mishra (2009), teachers should incorporate modern technology into their teaching process in a way that is tailored to their classroom environment. All of these are included in our research on an equal basis.

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References

- Abbitt, J. T. (2011). An investigation of the relationship between self-efficacy beliefs about technology integration and technological pedagogical content knowledge (TPACK) among preservice teachers. *Journal of Digital Learning in Teacher Education*, 27(4), 134-143.
- Asad, M. M., Hussain, N., Wadho, M., Khand, Z. H., & Churi, P. P. (2020). Integration of e-learning technologies for interactive teaching and learning process: An empirical study on higher education institutes of Pakistan. *Journal of Applied Research in Higher Education*, 13(2), 649-663. <https://doi.org/10.1108/JARHE-04-2020-0103>
- Brand, G. A. (1997). What research says: Training teachers for using technology. *Journal of Staff Development*, 19, 10-13.
- Cavanagh, R. F., & Koehler, M. J. (2013). A turn toward specifying validity criteria in the measurement of technological pedagogical content knowledge (TPACK). *Journal of Research on Technology in Education*, 46(2), 129-148. <https://doi.org/10.1080/15391523.2013.10782616>
- Chai, C. S., Koh, J. H. L., & Tsai, C. (2011). Exploring the factor structure of the constructs of technological, pedagogical, content knowledge (TPACK). *Asia-Pacific Education Researcher*, 20(3), 595–603. <http://hdl.handle.net/10497/4790>
- Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Journal of Educational Technology & Society*, 13(4), 63-73.
- Chai, C. S., Ng, E. M., Li, W., Hong, H., & Koh, J. H. L. (2013). Validating and modelling technological pedagogical content knowledge framework among Asian preservice teachers. *Australasian Journal of Educational Technology*, 29(1). <https://doi.org/10.14742/ajet.174>
- Cheng, K. (2017). A survey of native language teachers' technological pedagogical and content knowledge (TPACK) in Taiwan. *Computer Assisted Language Learning*, 30(7), 692–708. <https://doi.org/10.1080/09588221.2017.1349805>
- Cox, S., & Graham, C. R. (2009). Using an elaborated model of the TPACK framework to analyze and depict teacher knowledge. *TechTrends*, 53(5), 60-69.
- Cradler, J., McNabb, M., Freeman, M., & Burchett, R. (2002). How does technology influence student learning? *Learning and Leading with Technology*, 29(8), 46-49.
- Creswell, J. W. (2003). *Research design: qualitative, quantitative, and mixed methods approaches* (3rd Ed.). Sage. https://www.ucg.ac.me/skladiste/blog_609332/objava_105202/fajlovi/Creswell.pdf

- Daniels, T. (2002). Using the Internet to create an integrated thematic unit across the curriculum. In M. Driscoll & T. Reeves (eds.), *E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education* (pp. 1378-1381). <https://www.learntechlib.org/primary/p/9480/>
- Dong, Y., Chai, C. S., Sang, G., Koh, J. H. L., & Tsai, C. (2015). Exploring the profiles and interplays of pre-service and in-service teachers' technological pedagogical content knowledge (TPACK) in China. *Educational Technology & Society*, 18(1), 158–169. <https://www.jstor.org/stable/jeductechsoci.18.1.158>
- Flick, L., & Bell, R. (2000). Preparing tomorrow's science teachers to use technology: Guidelines for science educators. *Contemporary Issues in Technology and Teacher Education*, 1(1), 39-60. <https://www.learntechlib.org/primary/p/10803/>.
- Ghavifekr, S., & Rosdy, W. A. W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science*, 1(2). 175-191.
- Government of Pakistan. (1972). The Education Policy, 1972-1980. *Ministry of Education, Islamabad*.
- Greene, J. C. (2007). *Mixed methods in social inquiry* (Vol. 9). John Wiley.
- Hanban. (2015). *Standards for teachers of Chinese to speakers of other languages*. Confucius Institute Headquarters.
- Jang, S., & Chang, Y. (2016). Exploring the technological pedagogical and content knowledge (TPACK) of Taiwanese university physics instructors. *Australasian Journal of Educational Technology*, 32(1), 107–122. <https://doi.org/10.14742/ajet.2289>
- Koehler, M. J., Mishra, P., & Yahya, K. (2007). Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. *Computers & Education*, 49(3), 740-762. <https://doi.org/10.1016/j.compedu.2005.11.012>
- Koehler, M. J., Shin, T. S., & Mishra, P. (2012). How do we measure TPACK? Let me count the ways. In *Educational technology, teacher knowledge, and classroom impact: A research handbook on frameworks and approaches* (pp. 16-31). IGI Global. <https://doi.org/10.4018/978-1-60960-750-0.ch002>
- Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPCK)? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60–70. <https://www.learntechlib.org/primary/p/29544/>
- Koh, J. H. L. (2019). TPACK design scaffolds for supporting teacher pedagogical change. *Educational Technology Research and Development*, 67(3), 577-595.

- Koh, J. H. L., Chai, C. S., & Tsai, C. (2014). Demographic factors, TPACK constructs, and teachers' perceptions of constructivist-oriented TPACK. *Educational Technology & Society*, 17(1), 185–196. <https://www.jstor.org/stable/jeductechsoci.17.1.185>
- Koh, J. H. L., Chai, C. S., & Tsai, C. C. (2010). Examining the technological pedagogical content knowledge of Singapore pre-service teachers with a large-scale survey. *Journal of Computer Assisted Learning*, 26(6), 563–573. <https://doi.org/10.1111/j.1365-2729.2010.00372.x>
- Lee, K. T. (2002). Effective teaching in the information era: Fostering an ICT-based integrated learning environment in schools. *Asia-Pacific Journal of Teacher Education & Development*, 5(1), 21–45. https://eprints.qut.edu.au/secure/00003909/01/KarTin_Lee_APJTED-june02.pdf
- Lee, M., & Tsai, C. (2010). Exploring teachers' perceived self efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web. *Instructional Science*, 38(1), 1–21. <https://doi.org/10.1007/s11251-008-9075-4>
- Lin, T., Tsai, C., Chai, C. S., & Lee, M. (2013). Identifying science teachers' perceptions of technological pedagogical and content knowledge (TPACK). *Journal of Science Education and Technology*, 22(3), 325–336. <https://doi.org/10.1007/s10956-012-9396-6>
- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054. <https://doi.org/10.1111/j.1467-9620.2006.00684.x>
- Polly, D., & Martin, C. (2020). Design case for asynchronous online professional development in primary grades mathematics. In M. J. Bishop, E. Boling, J. Elen, V. Svihla (eds.), *Handbook of Research in Educational Communications and Technology* (pp. 789–797). Springer. https://doi.org/10.1007/978-3-030-36119-8_37
- Sandholtz, J. H. (1997). *Teaching with technology: creating student-centered classrooms*. Teachers College Press, Columbia University.
- Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, 42(2), 123–149. <https://doi.org/10.1080/15391523.2009.10782544>
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4–14. <https://doi.org/10.3102/0013189X015002004>
- Silverstein, G., Frechtling, J., & Miyoaka, A. (2000). Evaluation of the use of technology in Illinois public schools. *Final report prepared for Research Division, Illinois State Board of Education, Rockville, Westat*.

- Soomro, S., Soomro, A. B., Ali, N. I., Bhatti, T., Basir, N., & Gill, N. P. (2018). TPACK adaptation among faculty members of education and ICT Departments in University of Sindh, Pakistan. *International Journal of Advanced Computer Science and Applications*, 9(5), 203-209. <https://doi.org/10.14569/IJACSA.2018.090526>
- Tseng, J. J., Chai, C. S., Tan, L., & Park, M. (2022). A critical review of research on technological pedagogical and content knowledge (TPACK) in language teaching. *Computer Assisted Language Learning*, 35(4), 948-971. <https://doi.org/10.1080/09588221.2020.1868531>
- Tyarakanita, A. (2020). A case study of pre-service teachers' enabling TPACK knowledge: Lesson Design Projects. *ELS Journal on Interdisciplinary Studies in Humanities*, 3(2), 158-169. <https://doi.org/10.34050/els-jish.v3i2.10006>
- Vrasidas, C., & McIsaac, M. S. (2001). Integrating technology in teaching and teacher education: Implications for policy and curriculum reform. *Educational Media International*, 38(2-3), 127-132. <https://doi.org/10.1080/09523980110041944>
- White, N., Ringstaff, C., & Kelley, L. (2002). Getting the Most from Technology in Schools. Knowledge Brief. Eric. <https://eric.ed.gov/?id=ED471137>
- Xiong, X. B., Ching Sing, C., Tsai, C. C., & Liang, J. C. (2022). Exploring the relationship between Chinese pre-service teachers' epistemic beliefs and their perceptions of technological pedagogical content knowledge (TPACK). *Educational Studies*, 48(6), 750-771. <https://doi.org/10.1080/03055698.2020.1814698>
- Yaghi, H. M. (2001). Subject matter as a factor in educational computing by teachers in international settings. *Journal of Educational Computing Research*, 24(2), 139-154. <https://doi.org/10.2190/9YWV-DDUL-7G4F-6QVX>
- Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Sage. <https://doi.org/10.33524/cjar.v14i1.73>