

## Impact of the Teacher's Technological Pedagogical Skills at Higher Level

\* Rubina Usman

### Abstract



Technology has developed a complicated and necessary interaction with various sectors of society in the twenty-first century, offering multiple conceptual and practical models for incorporating technologies in teaching. (TPCK) provides chances for learners to develop critical thinking and creative potential as part of their personal growth. This research study explores teachers' perceptions regarding the Impact of the Teacher's Technological Pedagogical Content Knowledge (TPCK) on Student's Creativity skills at higher levels. 100 teachers of B. Ed (Hons) have been selected from 10 Universities in Karachi through simple random sampling. Reliability & Regression test has been run on SPSS for inferential statistics. Descriptive analysis revealed the age and gender details. This quantitative study revealed the significant relationship between teacher's Technological Pedagogical Content knowledge (TPCK) on Students' Creativity skills. It was found that technology-integrated teaching pedagogy develops students' interest, motivation, collaboration, critical thinking, social responsibility, and creativity. This study assists higher education teachers in comprehending the significance of Teacher Technological Pedagogical Content Knowledge (TPCK) on Student Creativity skills.

**Keywords:** Teacher's Technological Knowledge, Pedagogical knowledge, Content Knowledge, Student's Creativity skills, B.Ed. (Hon) Students

### Introduction

The enhancement of instructors' knowledge bases to improve teaching and student learning has been a major priority in teacher education worldwide (Abid et al., 2021). Teachers' awareness and capacity to use digital technology in classrooms help students to develop creativity (Ali, Azam, & Saba, 2023). The new technology tools have changed in 21<sup>st</sup>-century education. The global education need is turning towards technology-based teaching and learning (Ahmedovet al., 2023). To increase teaching and learning, modern teachers must understand how to integrate technology into classroom practice (Ali et al., 2020). Teachers nowadays must therefore understand how to integrate technology into classroom practice to improve teaching and learning. According to Ali, Rehman, and Ullah (2022) integrating technology tools into the teaching-learning process through technological and pedagogical skills. Self-efficacy is concerned with an individual's belief in his or her ability to do a given activity. Self-efficacy is one component of teacher education that is thought to influence teachers' professional lives (Baran et al., 2019). This research revealed three types of knowledge: technological knowledge, instructional knowledge, and content knowledge enhances students' creativity skills. Students develop self-direction skills. According to Ali, Thomas, & Hamid (2020) teachers need to develop their technological pedagogical skills to satisfy the digital natives of the 21st century. CPD regarding technology and pedagogy develops teacher's technological pedagogy in the teaching and learning process.

Bwalya and Rutegwa (2023) found that the interest in the problems of creativity and creativity of educational activity in today's modern society is increasing. This is related to the possibility of developing creative thinking in objective and social activities for the self-awareness of the individual in the development of personality, the need to develop the abilities of future engineers to find the right solution in problem situations, to act effectively. He further found that increasing the creative activity of future engineers is related to the orientation to new approaches and the creation of favorable pedagogical conditions for its effective development. the problem of creating the necessary pedagogical conditions and creative environment to understand the essence of educational reforms has arisen.

For integrating technology in teaching and learning, Capobianco, and Lehman (2018) suggested the technological pedagogical content knowledge (TPACK) approach. The TPACK model

\* University of Karachi Email: [rubinajahangir1@gmail.com](mailto:rubinajahangir1@gmail.com)

highlighted the importance of technology in the teaching and learning process to improve teachers' knowledge and abilities. TPACK refers to teachers' ability to integrate material, pedagogy, and technological knowledge into a learning practice. According to Mishra and Koehler (2006), TPACK is enhanced technological pedagogy.

According to Ali et al. (2020) most pre-service teachers don't have ICT skills and knowledge; many kinds of literature suggest that pre-service teachers should be IT literate. They didn't integrate technology into the teaching and learning process in Pakistan. They faced many problems according to the observation of many researchers, they mentioned some problems such as a lack of technology integration training. It was discovered that pre-service education Teachers received no training in teaching with technology. Previous research has concentrated on the evaluation of in-service technology integration, they describe teachers in Zambia. In this context, one alternative strategy for developing TPACK in teachers attempts to improve teachers' pedagogical practice through collaborative research of Teaching. According to Wang (2024), universities can use the knowledge of the association between demographic characteristics and teachers' TPACK perceptions to develop appropriate teacher training programs.

Self-efficacy is defined as one's self-assessment of a teacher's capacity to successfully ideas and take out a specific project. Self-efficacy is concerned with an individual's belief in his or her ability to do a given activity. Self-efficacy is one component in teacher education that is thought to influence the teachers' professional lives. This research revealed three types of knowledge: technological knowledge, instructional knowledge, and content knowledge enhances students' creativity skills. Students develop self-direction skills. Teachers need to develop their technological pedagogical skills to satisfy the digital natives of the 21<sup>st</sup> century. CPD regarding technology and pedagogy develops teacher's technological pedagogy in the teaching and learning process (Wang, & Sun, 2024).

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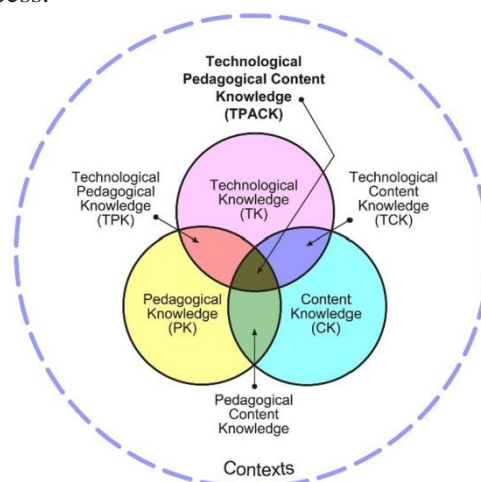
Hair et al. (2019) found that technology-integrated teaching pedagogy develops students' interest, motivation, collaboration, critical thinking, social responsibility, and creativity. He further revealed that technology-enhanced teacher's 21<sup>st</sup>-century instructional skills. Technology provides ways of unique ideas of activities that promote higher-order thinking and extended thinking. Web 2.0 and 4.0 online tools are the need of the current century for both students and teachers to develop a proactive learning culture in the classrooms of every subject.

Hall, Lei, and Wang (2020) revealed that content knowledge is enhanced through technology-aided learning teaching tools, which develop teachers' and students' critical thinking as well as creativity. Students develop creativity skills after engaging in these technology-based activities, assignments, and assessments. For integrating technology in teaching and learning, and suggested the technological pedagogical content knowledge (TPACK) approaches. The TPACK model highlighted the importance of technology in the teaching and learning process to improve teachers' knowledge and abilities. TPACK refers to teachers' ability to integrate material, pedagogy, and technological knowledge into a learning practice. According to Mishra and Koehler (2006), TPACK is enhanced technological pedagogy.

According to Ho et al. (2023), most pre-service teachers don't have ICT skills and knowledge, Many kinds of the literature suggest that pre-service teachers should be IT literate. They didn't integrate technology into the teaching and learning process in Pakistan. They faced many problems according to the observation of many researchers, they mentioned some problems such as a lack of technology integration training. They discovered that pre-service education Teachers received no training in teaching with technology.

Jiménez Sierra et al. (2023) explore the barriers faced by students in teacher-centered classrooms during the learning process. He found students as digital natives and teachers as digital immigrants. He suggested CPD for teachers related to ICT pedagogical practices. Technology tools support students to create and explore. Self-efficacy is concerned with an individual's belief in his or her ability to do a given activity. Self-efficacy is one component in teacher education that is thought to influence the teachers' professional lives. This research revealed three types of knowledge: technological knowledge, instructional knowledge, and content knowledge enhances students' creativity skills. Students develop self-direction skills.

Bwalya and Rutegwa (2023) found that the interest in the problems of creativity and creativity of educational activity in today's modern society is increasing. This is related to the possibility of developing creative thinking in objective and social activities for the self-awareness of the individual in the development of personality, the need to develop the abilities of future engineers to find the right solution in problem situations, to act effectively. He further found that increasing the creative activity of future engineers is related to the orientation to new approaches and the creation of favorable pedagogical conditions for its effective development. the problem of creating the necessary pedagogical conditions and creative environment to understand the essence of educational reforms has arisen. Ali et al. (2023) found the need for Technological Pedagogical and Content Knowledge of Pre-Service Elementary School Teachers in Karachi. He explores the need for training regarding the ICT pedagogy of pre-service teachers. Jimoyiannis, and Koukis (2023). explore the tools for assessing teacher digital literacy skills. He found the shortage and lack of evaluation tools in the teaching and learning process. They revealed the technology instructional design in learning. He found that technology design helps teachers design a good instructional plan, which promotes and enhances creativity skills among students. They explored teachers' readiness and beliefs about emergency remote teaching amid the COVID-19 pandemic. He found that the Technological Pedagogy of teachers helps them to teach in a pandemic. He explored the importance of technological pedagogy in the teaching and learning process.



According to Long et al. (2022) technology-assisted learning is a continuation of prior mastering paradigms, as traditional learning has evolved into electronic learning, digital learning has evolved into mobile learning, and we have now moved on to ubiquitous learning. Ubiquitous learning occurs at any time and in any location in a ubiquitous computer environment based on mobile devices, wi-fi gadgets, and wireless networks. According to Ali et al. (2020) students are technological natives in the twenty-first century, whereas teachers are technology immigrants.

U learning aids teachers in offering technology-integrated learning while simultaneously fostering the 4Cs of 21st-century talents (Critical thinking, Creativity, Collaboration, and Communication). To generate 21st-century 4Cs, most university lecturers may struggle and attempt to include technology web 2.0 technologies into their teaching and learning process. Because they are seeking to teach digital natives, Noreen (2016) explored how teaching is a difficult process in the twenty-first century. The majority of students intended to use technology and anticipated that their professors would provide technology-assisted learning. Zulkifli et al. (2022) explored the importance of technology in science education. Skantz-Åberg (2022) found Teachers' professional digital competence is very helpful in the active learning environment of the 21st century. Self-efficacy is concerned with an individual's belief in his or her ability to do a given activity. Self-efficacy is one component of teacher education that is thought to influence teachers' professional lives (Baran et al., 2019). This research revealed three types of knowledge: technological knowledge, instructional knowledge, and content knowledge enhances students' creativity skills. Students develop self-direction skills.

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**Research Model:**



The objective of this research is to know the Impact of the Teacher's Technological Pedagogical Content Knowledge (TPCK) on Student's Creativity skills at a higher level.

The hypothesis of this research is:

H0: There is no any significant relationship between the Teacher's Technological Pedagogical Content Knowledge (TPCK) and the Student's Creativity.

H1: There is a significant relationship between the Teacher's Technological Pedagogical Content Knowledge (TPCK) and the Student's Creativity.

**Review of Literature**

Ahmedov (2023) revealed an organization of Technological Educational Processes and Using the Method of " Integration Strategy" in Improving the Management System. He further found technology as a learning tool in the teaching and learning process. Ho et al. (2023) found that promoting pre-service teachers' psychological and pedagogical competencies for online learning and teaching. According to Ho pre-service teachers should learn technological pedagogy.

Thohir (2022) explored that pre-service teachers help students develop critical thinking and creativity skills. At this point in history, the subject of personal maturity, creativity, and the creative capacities of future engineers is interpreted through the lens of several methods.

Tseng (2022) explored that computer Assisted Language Learning develops creativity among students and learners of the 21<sup>st</sup> century. These expectations are related to future working abilities such as ICT skills and literacy. Jiménez Sierra (2023) found that technology-integrated teaching pedagogy develops students' interest, motivation, collaboration, critical thinking, social responsibility, and creativity. He further revealed that technology-enhanced teacher's 21<sup>st</sup>-century instructional skills. Technology provides ways of unique ideas of activities that promote higher-order thinking and extended thinking. Web 2.0 and 4.0 online tools are the need of the current century for both students and teachers to develop a proactive learning culture in the classrooms of every subject. For integrating technology in teaching and learning they suggested the technological pedagogical content knowledge (TPACK) approach. The TPACK model highlighted the importance of technology in the teaching and learning process to improve teachers' knowledge and abilities. TPACK refers to teachers' ability to integrate material, pedagogy, and technological knowledge into a learning practice.

According to Lou et al. (2023), most pre-service teachers don't have ICT skills and knowledge, Many kinds of the literature suggest that pre-service teachers should be IT literate. They didn't integrate technology into the teaching and learning process in Pakistan. They faced many problems according to the observation of many researchers, they mentioned some problems such as a lack of technology integration training. They discovered that pre-service education Teachers received no training in teaching with technology.

Luo et al. (2023) revealed that content knowledge is enhanced through technology-aided learning teaching tools, which develop teachers' and students' critical thinking as well as creativity. Students develop creativity skills after engaging in these technology-based activities, assignments, and assessments.

Lyublinskaya and Du (2022) explore the barriers faced by students in teacher-centered classrooms during the learning process. He found students as digital natives and teachers as digital immigrants. He suggested CPD for teachers related to ICT pedagogical practices. Technology tools support students to create and explore. Ali et al. (2023). Explored the need for training regarding the ICT pedagogy of pre-service teachers. Nguyen and Habok (2024) explore the tools for assessing teacher digital literacy skills. He found the shortage and lack of evaluation tools in the teaching and learning process. Muthmainnah (2023) revealed the technology instructional design in learning. He found that technology design helps teachers design a good instructional plan, which promotes and enhances creativity skills among students. Jimoyiannis and Koukis (2023) found that the Technological Pedagogy of teachers helps them to teach in a pandemic. He explored the importance of technological pedagogy in the teaching and learning process. Long et al. (2022) found that thinking skills can be enhanced through technology and modern tools of pedagogy. The National Curriculum (Finnish National Board of Education, 2015) underlines the importance of ICT as both a technique and a goal of learning in the framework of the Finnish educational system. ICT is a component of today's young and pre-service teachers' daily lives. However, obtaining the knowledge and abilities to use ICT in pedagogically meaningful ways, as well as understanding. Zulkifli et al. (2022) explored the importance of technology in science education. Skantz-Åberg (2022). found Teachers' professional digital competence is very helpful in the active learning environment of the 21st century.

Scherer et al. (2018) report that today's pre-service teachers have generally positive attitudes toward the possibilities of ICT in education; however, attitudes are more restrained. Furthermore, according to Wang, and Zhao (2021), pre-service teachers appear to be regularly uncomfortable with incorporating technology into education. They found teachers' lack of skills and knowledge is a barrier to using ICT in education. For integrating technology in teaching and learning, Mishra and Koehler (2006) suggested the technological pedagogical content knowledge (TPACK) approach. The TPACK model highlighted the importance of technology in the teaching and learning process to improve teachers' knowledge and abilities. TPACK refers to teachers' ability to integrate material, pedagogy, and technological knowledge into a learning practice.

According to Jita & Sintema (2022), most pre-service teachers don't have ICT skills and knowledge, Many kinds of the literature suggest that pre-service teachers should be IT literate. They didn't integrate technology into the teaching and learning process in Pakistan (Kafyulilo 2019). They faced many problems according to the observation of many researchers, they mentioned some problems such as a lack of technology integration training (Niess 2019). Sintema (2019) discovered that pre-service education Teachers received no training in teaching with technology. Ho (2023)

found that promoting pre-service teachers’ psychological and pedagogical competencies for online learning and teaching. According to Ho pre-service teachers should learn technological pedagogy.

**Methods**

This is a descriptive and quantitative study to identify the impact of the Teacher's Technological Pedagogical Content Knowledge (TPCK) on Student's Creativity Skills at a Higher Level. This study is descriptive, Survey method was used to collect primary data. The deductive approach was used in this study. This study is quantitative and cross-sectional. The population of this study is the institutions of higher education in Pakistan. 15 universities in Karachi are the target sample of this study.150 teachers (10 teachers from each university) have been chosen for data collection as respondents. These teachers are picked through simple random sampling from 15t private and public universities in Karachi. The research tool of this study is a close-ended questionnaire consisting of 30 items having a 07 Likert scale. This tool is distributed to teachers through an online Google form. A consent letter has been shared and signed by teachers. SPSS has been used for inferential and descriptive analysis. Reliability and Regression tests have been run through SPSS to analyze the data. Descriptive analysis revealed about Age, Gender, and IT skills of 150 teachers through charts.

**Data Analysis**

According to descriptive statistics, there are 65 females and 35 males over the age of 30 among the 150 teachers. There are 12 females and 12 males above the age of 40. There are 18 ladies and 8 males over the age of 50. The greatest proportion of teachers are over the age of 30. There are 95 female teachers and 55 male teachers among the 150 total. Females outnumber men in the study. According to this study, 51% of instructors are novice users of technology, 33% are average users, and 16% are advanced users.

**Reliability Statistics**

Cronbach's Alpha	N of Items
.795	20

**Table 4.1**

The value of Cronbach's Alpha in Table 4.1 is ( =.795), which is adequate for item reliability and indicates that all questionnaire items are 80 percent reliable.

**Regression Model Summary**

Model	R	r <sup>2</sup>	S. E	D-Watson
1	.989 <sup>a</sup>	.885	1.46649	1.769

**Table 4.2**

- a. Predictors: (Constant), **TPCK**
- b. Dependent Variable: **SC**

The value of r2 is 885, as shown in Table 4.2. This number indicated that the model explained 88% of the variance. On the other side, the table displayed the value of R square, indicating that the model was fit. In the table above, the F value is 74.510 at the 000 significant level, which is less than 1%. As a result, the model's fitness was validated.

**4.3 Hypothesis testing**

H 1	V	C	t	P	Decision
H1: TPCK has a significant relationship with SC	SC	.342	6.435	.001	Accepted

**Table 4.3**

**H1: There is a significant relationship between the Teacher's Technological Pedagogical Content Knowledge (TPCK) and the Student's Creativity.**

Table 4.3 displays the t-value of 5.079 and the p-value of.000 less than 0.05. That equals 000. It indicates that H1 is acceptable. According to the current study, teachers' Technological Pedagogical Content Knowledge (TPCK) has a considerable impact on students' creativity.

**Findings of the study**

It was found that technology-integrated teaching pedagogy develops students' interest, motivation, collaboration, critical thinking, social responsibility, and creativity. It was also noted that teaching based on technology in a creative environment improves students' creative skills. It was found This

research revealed three types of knowledge: technological knowledge, instructional knowledge, and content knowledge enhances students' creativity skills.

### **Conclusion and Discussion**

TPACK refers to teachers' ability to integrate material, pedagogy, and technological knowledge into a learning practice. According to Wang and Zhao (2021) most pre-service teachers' doesn't have ICT skills and knowledge. They suggested that pre-service teachers should be IT literate. They didn't integrate technology into the teaching and learning process. They faced many problems according to the observation of many researchers, they mentioned problems such as lack of technology integration training they discovered that pre-service education Teachers received no training in teaching with technology. This research has concentrated on the evaluation of in-service technology integration. It was concluded that technology is essential for the creative skill development of students. This study favors the findings of the current study.

Technological knowledge, instructional knowledge, and content knowledge enhance students' creativity skills. Students develop self-direction skills. Teachers need to develop their technological pedagogical skills to satisfy the digital natives of the 21<sup>st</sup> century (Zulkifli et al., 2022). The results of this support the findings of the present study. According to Ali et al. (2020), students are technological natives in the twenty-first century, whereas teachers are technology immigrants. This study too favors the findings of this study. Skantz-Åberg (2022) found Teachers' professional digital competence is very helpful in the active learning environment of the 21st century. It also supports the result of this study.

Jiménez Sierra (2023) found that technology-integrated teaching pedagogy develops students' interest, motivation, collaboration, critical thinking, social responsibility, and creativity. The findings of this study are supported by this study. Luo et al. (2023) revealed that content knowledge is enhanced through technology-aided learning teaching tools, which develop teachers' and students' critical thinking as well as creativity. Students develop creativity skills after engaging in these technology-based activities, assignments, and assessments. Similarly, Bwalya and Rutegwa (2023) found that the interest in the problems of creativity and creativity of educational activity in today's modern society is increasing. These are related to the findings of this study.

### **Recommendations**

Based on the findings and conclusions of the study, teachers may give proper training in the use of technology-based teaching which can improve their technological pedagogical skills of teachers in turn augment students' creative skills. It is also recommended that learners be trained for self-learning with the help of technology-based learning tools.

### **References**

- Abid, T., Zahid, G., Shahid, N., & Bukhari, M. (2021). Online teaching experience during the COVID-19 in Pakistan: Pedagogy–technology balance and student engagement. *Fudan Journal of the Humanities and Social Sciences*, 14(3), 367-391.
- Ahmedov, M. M., Ruzimatova, S. M., & Yoldashev, A. Y. (2023). Organization of Technological Educational Processes and Using the Method of" Integration Strategy" in Improving the Management System. *Journal of Pedagogical Inventions and Practices*, 19, 1-6.
- Alayyar, G. M., Fisser, P., & Voogt, J. (2012). Developing technological pedagogical content knowledge in pre-service science teachers: Support from blended learning. *Australasian journal of educational technology*, 28(8).
- Ali, Z., Azam, R., & Saba, F. (2023). Technological Pedagogical and Content Knowledge of Pre-Service Elementary School Teachers in Karachi, Pakistan: A Quantitative Study. *Journal of Social Sciences Review*, 3(1), 678-688.
- Ali, Z., Busch, M., Qaisrani, M. N., & Rehman, H. U. (2020). The influence of teachers' professional competencies on students' achievement: a quantitative research study. *American Research Journal of Humanities & Social Science*, 3(6), 45-54.
- Ali, Z., Rehman, H. U., & Ullah, N. (2022). Measuring University Teacher Educators' Knowledge and Skills Using TPACK in Teachers Education Programs. *Research Journal of Social Sciences and Economics Review*, 3(3), 83-91.
- Ali, Z., Thomas, M., & Hamid, S. (2020). Teacher Educators'perception of Technological Pedagogical and Content Knowledge on their Classroom Teaching. *New Horizons (1992-4399)*, 14(2)

- Ali, Z., Thomas, M., Ahmed, N., Ahmed, I., & Ahmed, I. (2020). Assessment of Pre-Service Teacher's Perceptions on Technological Pedagogical and Content Knowledge (TPACK) in Karachi Pakistan. *International Journal of Scientific & Engineering Research*, 11(3), 1402-1407.
- Baran, E., Canbazoglu Bilici, S., Albayrak Sari, A., & Tondeur, J. (2019). Investigating the impact of teacher education strategies on preservice teachers' TPACK. *British Journal of Educational Technology*, 50(1), 357-370.
- Bwalya, A., & Rutegwa, M. (2023). Technological pedagogical content knowledge self-efficacy of pre-service science and mathematics teachers: A comparative study between two Zambian universities. *Eurasia Journal of Mathematics, Science and Technology Education*, 19(2), 22.
- Capobianco, B. M., & Lehman, J. (2018, June). Examining and characterizing elementary school teachers' engineering design-based instructional practices and their impact on students' science achievement. In *2018 ASEE Annual Conference & Exposition*.
- Chai, C. S., Hwee Ling Koh, J., & Teo, Y. H. (2019). Enhancing and modeling teachers' design beliefs and efficacy of technological pedagogical content knowledge for 21st-century quality learning. *Journal of Educational Computing Research*, 57(2), 360-384.
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2-24.
- Hall, J. A., Lei, J., & Wang, Q. (2020). The first principles of instruction: An examination of their impact on preservice teachers' TPACK. *Educational Technology Research and Development*, 68, 3115-3142.
- Ho, H. C., Poon, K. T., Chan, K. K. S., Cheung, S. K., Datu, J. A. D., & Tse, C. Y. A. (2023). Promoting preservice teachers' psychological and pedagogical competencies for online learning and teaching: The TEACH program. *Computers & Education*, 195, 104725.
- Jiménez Sierra, Á. A., Ortega Iglesias, J. M., Cabero-Almenara, J., & Palacios-Rodríguez, A. (2023, February). Development of the teacher's technological pedagogical content knowledge (TPACK) from the Lesson Study: A systematic review. In *Frontiers in Education* (Vol. 8, p. 1078913). Frontiers.
- Jimoyiannis, A., & Koukis, N. (2023). Exploring teachers' readiness and beliefs about emergency remote teaching amid the COVID-19 pandemic. *Technology, Pedagogy and Education*, 32(2), 205-222.
- Long, T., Zhao, G., Li, X., Zhao, R., Xie, K., & Duan, Y. (2022). Exploring Chinese in-service primary teachers' Technological Pedagogical Content Knowledge (TPACK) for the use of thinking tools. *Asia Pacific Journal of Education*, 42(2), 350-370.
- Luo, W., Berson, I. R., Berson, M. J., & Park, S. (2023). An exploration of early childhood teachers' Technology, Pedagogy, and Content Knowledge (TPACK) in Mainland China. *Early Education and Development*, 34(4), 963-978.
- Lyublinskaya, I., & Du, X. (2022). Preservice teachers' TPACK learning trajectories in an online educational technology course. *Journal of Research on Technology in Education*, 1-18.
- Muthmainnah, M. (2023). Expanding on the use of YouMiMe as technology instructional design in learning. *Pegem Journal of Education and Instruction*, 13(1), 367-378.
- Nguyen, L. A. T., & Habók, A. (2024). Tools for assessing teacher digital literacy: a review. *Journal of Computers in Education*, 11(1), 305-346.
- Scherer, R., Tondeur, J., Siddiq, F., & Baran, E. (2018). The importance of attitudes toward technology for pre-service teachers' technological, pedagogical, and content knowledge: Comparing structural equation modeling approaches. *Computers in Human Behavior*, 80, 67-80.
- Skantz-Åberg, E., Lantz-Andersson, A., Lundin, M., & Williams, P. (2022). Teachers' professional digital competence: An overview of conceptualizations in the literature. *Cogent Education*, 9(1), 2063224.
- Thohir, M. A., Jumadi, J., & Warsono, W. (2022). Technological pedagogical content knowledge (TPACK) of pre-service science teachers: A Delphi study. *Journal of Research on Technology in Education*, 54(1), 127-142.



- 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.
- Wang, Q., & Zhao, G. (2021). ICT self- efficacy mediates most effects of university ICT support on preservice teachers' TPACK: Evidence from three normal universities in China. *British Journal of Educational Technology*, 52(6), 2319-2339.
- Wang, Y., & Sun, P. P. (2024). Development and validation of scales for speaking self-efficacy: Constructs, sources, and relations. *Plos one*, 19(1), e0297517.
- Zulkifli, Z., Satria, E., Supriyadi, A., & Santosa, T. A. (2022). Meta-analysis: The effectiveness of the integrated STEM technology pedagogical content knowledge learning model on the 21st-century skills of high school students in the science department. *Psychology, Evaluation, and Technology in Educational Research*, 5(1), 32-42.