Remittances Review
April 2024,
Volume: 9, No: 2, pp.743-754
ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

Received : 03 February 2024, Accepted: 07 March 2024
DOI: https://doi.org/10.33282/rr.vx9i2.42

TPACK and ICT, the new hope for Pakistan's education system: analysis of the perception of prospective teachers

Sabir Hussain[1], Fakhar-Ul-Zaman[2], Dr. Bilqees Khanum[3], Mesha Kanwal[4], Tariq Hussain[5], Irfan Nawaz[6], Muhammad Imran Thaheem[7]

1. Ph.D. Scholar, Department of Educational Training, The Islamia University of Bahawalpur, Pakistan. Email: sabirjanmarri@gmail.com
2. Visiting Lecturer, Department of Education, University of Narowal, Punjab, Pakistan. Email: malikfakhar717@gmail.com
3. Visiting lecturer in Education, University of Narowal, Punjab, Pakistan. Email: bilqees4321@gmail.com
4. MS scholar in Education, University of Sialkot, Punjab, Pakistan. Email: mishabajwa123@gmail.com
5. M.Phil. Special Education, AIOU, Islamabad, Pakistan. Email: thtbaltistani@gmail.com
6. M.Phil. Education, The Islamia University of Bahawalpur, Pakistan. Email: engrirfannawazbhatti1@gmail.com
7. M.Phil. Education (Institute of Southern Punjab, Multan), Punjab, Pakistan. Email: muhammadimranthaheem127@gmail.com

Abstract

In this advanced age, when the Industrial Revolution came, the demand for revolutionary education also increased. Traditional education is close to extinction, ICT has revolutionized the education field, educational priorities have increased, and only those teachers who have technological pedagogical content knowledge are successful. After receiving traditional education, most students are unemployed, but the demand for teachers who have enhanced their skills through ICT and TPACK has increased. Only those who are familiar with information and communication technology and technological pedagogical content knowledge can successfully get jobs in Pakistan as well as other developed countries and score jobs in the international market. This research aimed to check the perception and attitude of Pakistani prospective teachers towards ICT and TPCAK. For this purpose, 200 prospective teachers doing B.Ed., M.Ed., M.Phil., and Ph.D. education from three teacher education institutions in South Punjab were selected as samples and asked about their perception about ICT and TPACK. Their perception and attitude towards ICT and TPACK were observed through a 5-point Likert scale. Prospective teachers' perception of information and communication was found to be positive. Their perception and attitudes towards technological knowledge, pedagogical knowledge, content knowledge, and technological pedagogical were positive. It is recommended that ICT and TPACK be included in the training of prospective teachers and that competent trainers who are well versed in ICT and TPACK be hired for the training. The

school and college level curriculum should also be integrated with ICT so that students can join the new educational revolution and compete positively with the world.

Keywords: Information and Communications Technology (ICT), Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), and Technological Content Knowledge (TCK).

Introduction

According to Nelson Mandela, education is "the most powerful weapon that can be used to change the world" (Madimbo, 2015). Without a doubt, Pakistan's educational system is in desperate need of reform in the present day. Incorporating Information and Communication Technology (ICT) into our teaching methodologies and classrooms is essential to achieve equity in education, excellent learning and teaching, professional development of teaching staff, and an efficient education system (Fannakhosrow et al., 2022).

Scientific and technological breakthroughs occurred at a dizzying rate, ushering in the 5.0 generation industrial revolution. As we enter the fourth industrial revolution, digital technology, AI, big data, and robotics permeate every facet of society (Musarat et al., 2023). These shifts highlight the importance of incorporating technology into the educational process. When discussing the best ways to integrate technology into the classroom, education professionals often refer to the idea of TPACK education (Thohir et al., 2022). When it comes to equipping the next generation to tackle the problems of the modern digital age, education is an essential sector. Teachers must master the art of making good use of technology in the classroom in order for students to keep up with the rapidly evolving information and communication landscape. Anyone planning to become a teacher, whether at the university or high school level, should read this (Tanjung, 2022).

According to Zhang and Chen (2023), the world's development challenges are shifting towards a greater emphasis on the need for human resources (HR) with expertise in science, technology, art, and other related fields. As the world is changing at a rapid pace, educational practices must also evolve to meet the demands of this new reality. Such a phenomenon is most noticeable in relation to the advancement of ICT. Education is just one area that has been impacted by the rise of IT (Aslan & Shiong, 2023). Beginning in 2006, innovations in educational technology aimed at addressing learning issues began to take shape (Yang et al., 2022). In order to address learning difficulties in a more systematic and controlled way, this paradigm is geared toward describing educational technology (Akour & Alenezi, 2022). Based on its history, educational technology can be defined as a methodical approach to addressing challenges in education. The majority of educators have recently come to recognize the value of technology in the classroom, but few have made any efforts to incorporate it into their lessons (Snezhko et al., 2022). A student's ability to learn is affected by their teachers. If we want better education for more people, we need better teachers (Sulthani & Thoifah, 2022).

When it comes to education, the teacher plays a role in determining how well students learn. It is not enough for teachers to simply be knowledgeable in their field; they must also be competent in guiding their students to a variety of resources, both within and outside the classroom, to further their education (Huang et al., 2022). According to Alwi and Mumtahana (2023), teachers should also be capable of setting up learning environments in a way that allows students to acquire the most comprehensive knowledge possible. Consequently, educators, particularly those working during the Industrial Revolution, were expected to possess extensive knowledge of scientific and technological subjects. Training the next generation of educators to make good use of technology presents this obstacle (Mutiara, 2022). Having computer skills is just one aspect of technology use; knowledge of and care for data and technological communication are also important (Zhang et al., 2022). The use of information and communication technologies (ICT) in the classroom has several implications, one of which is the need for instructors to possess strong technological competence in addition to subject and pedagogical expertise (Demissie et al., 2022).

There will be a continued demand for educators in the twenty-first and beyond to hasten the evolution of communication and information technologies. Adapting teaching methods and classroom management strategies for the 21st century to meet the expectations of the most recent developments in information and communication technology is an absolute necessity. Educators in the modern era face seven main obstacles, including a) the ability to teach in a multilingual and culturally diverse society; b) the importance of teaching for active learning; c) the role of technology in the classroom; e) the need to teach with a fresh perspective on abilities; f) the role of choice in the classroom; and g) the role of accountability in the classroom (Gumus, 2022).

Technological Pedagogical Content Knowledge (TPACK) is defined as the capacity to utilize technology while simultaneously attending to its pedagogical and content-related aspects (Li et al., 2022). Teachers need strong communication skills to help their students understand and implement what they've learned. This is because learning is a dynamic process that occurs when people engage with their environment and acquire new information, skills, and behaviours. Thus, in order for students to become professional future teachers, it is essential that they learn early on how to effectively communicate what they know, specifically the correct material content, through effective pedagogical activities. Facts, information, principles, laws, theories, and a thorough understanding of the subject matter make up what is known as "content" (Abdurrahman et al., 2029). Teaching strategies that address students' unique learning needs are part of pedagogics (Varas et al., 2023).

Knowing the theories and principles of effective learning and having an appreciation for students' characteristics and potential are also essential components of pedagogics (Cai et al., 2023). Pakistan must raise its educational standards to remain competitive in the modern industrial age (Tahir & Farooq, 2023). If Pakistani education is to realize its potential, there must be an uptick in both teacher quality and student achievement. Consequently, students aspiring to become teachers need to be proficient with this technology. Prospective educators, in particular, may find it challenging to incorporate technology into their lessons (Nayazi et al., 2023). In order to choose the best technology, a future educator needs to have a firm grasp of

the subject matter. According to Erfan et al. (2023), prospective teachers must possess Technological Pedagogical and Content Knowledge (TPACK) in addition to mastery of subject matter in order to effectively implement learning.

Despite the obvious benefits of technology in the classroom, many educators have only recently begun to see its potential. Raising the bar for educational excellence begins with a qualified teaching staff. As stated by Prabawati et al. (2023), educators have the responsibility of developing and executing lesson plans, administering assessments, performing research and studies, and establishing lines of communication with members of the community.

According to field research (Siddiqui et al., 2023), problems with teacher standards, material mastery, and low media and technology literacy persist in Pakistani schools and classrooms. Teachers' capacity to create TPACK (Technological Pedagogical Content Knowledge) professional development plans is a big obstacle for Pakistani education in the global complex (Ali et al., 2023). TPACK refers to a thorough amalgamation of material, pedagogical, and technologically advanced knowledge and abilities. Shulman coined the term "TPACK" in 1987, and Koehler and Mishra refined it in 2008. According to Angeli and Valanides (2014), TPACK is a promising framework that could lead educators in new ways when they need to address issues surrounding the integration of ICT into classroom instruction.

There are various components to TPACK, including TK for technological knowledge, PK for pedagogical knowledge, CK for content knowledge, TPK for technological pedagogical knowledge, PCK for pedagogical content knowledge, and TCK for technological content knowledge.

Content Knowledge (CK)

An individual's content knowledge is their familiarity with the intended field of study or area of instruction. Also crucial is the capacity to know the subject matter inside and out, as this dictates the unique perspective taken by each researcher (Schiering et al., 2023).

Pedagogical Knowledge (PK)

The capacity to manage a classroom, create effective lesson plans, organize meaningful learning experiences, recognize and address individual student needs, and evaluate student progress is known as pedagogical knowledge. The overarching goal of information in the classroom is defined by pedagogical knowledge. Teachers need to hone their teaching abilities so they can effectively lead their students in learning activities and reach set objectives. The second part is what's known as pedagogical knowledge (PK), which encompasses topics like educational goals, managing a classroom, creating curricula, and managing and developing lessons (Zeng et al., 2023).

Technological Knowledge (TK)

One definition of technological knowledge is familiarity with a wide range of digital and non-digital tools and techniques (Padmavathi, 2017). The capacity to learn and adapt to new

technologies is a part of technological knowledge. The ever-increasing pace of technological advancement makes this skill a necessity (Brianza et al., 2023).

Technological Pedagogical Knowledge (TPK)

Modern Technology Pedagogical knowledge encompasses both theoretical and practical understanding of how-to best use technology in the classroom. The two-way street between tech and education is the root cause of TPK. New methods of instruction can be made more accessible and usable with the help of technological advancements (Gerhard et al., 2023).

Pedagogical Content Knowledge (PCK)

The capacity to incorporate one's knowledge of the subject matter into one's teaching is known as pedagogical content knowledge. Future educators can benefit from Pedagogical Content Knowledge by learning how to tailor their teaching methods to the specifics of each subject area. Being well-versed in both content and pedagogy is more than simply knowing your stuff or having a general idea of what works in the classroom; it's about getting the nitty-gritty of how the two interact with one another (Sen, 2023).

Technological Pedagogical and Content Knowledge (TPACK)

Modern technology, as defined by Jiménez Sierra et al. (2023) and Abubakir and Alshaboul (2023), "pedagogical knowledge" encompasses both theoretical and practical knowledge of how to best incorporate technology into the classroom. TPACK is a model for defining and comprehending the body of knowledge that educators need to effectively incorporate technology into their classrooms in order to improve student learning and teacher effectiveness. A theory and concept for researchers and educators, the TPACK framework measures whether or not a candidate is prepared to teach effectively using technology.

Statement of the Problem

In modern times, where the world is developing rapidly, the Industrial Revolution is also progressing rapidly; the Industrial Revolution has changed the demand for skilled persons in the market. The need to change the educational curriculum according to the market demand is automatic because to meet the demand of the modern market, the demand for general traditional education has suddenly disappeared. The current industrial revolution is also having an impact on Pakistan. However, in Pakistan, the industry is developing very slowly, but the educated youth of Pakistan work in other developed countries, so they need modern, skilled education. Modern education has become indispensable in the present age. ICT and TPACK have become professional skills for teachers. Traditional teacher training is no longer helpful in Pakistan because the curriculum is now technology-integrated, and the teacher will also have to be proficient in ICT and TPACK over time. This research aimed to determine prospective teachers' attitudes and perceptions about ICT and TPACK and highlight the importance of ICT and TPACK.

Objectives of the Study

The main objective of this research was as follows;

1. The analysis of the perception of prospective teacher's Information and Communications Technology (ICT), Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), and Technological Content Knowledge (TCK).
2. One objective of this research was to give revolutionized suggestions in education and to integrate teacher training with new pedagogical skills according to modern requirements so that prospective teachers in the field can meet the new learning requirements of students and build teaching and learning efficiency by integrating technology.

Research Questions of the Study

This research aimed to find answers to the following questions;

1. Are prospective teachers receiving information and communication training?
2. Are prospective teachers receiving technological knowledge training?
3. Are prospective teachers receiving pedagogical knowledge training?
4. Are prospective teachers receiving content knowledge training?
5. Are prospective teachers receiving training in technological pedagogical knowledge?
6. Are prospective teachers receiving pedagogical content knowledge training?
7. Are prospective teachers receiving technological content knowledge training?

Significance of the Study

i. The findings of the research will prove to be very useful in the Pakistani education field because the traditional teaching-learning method is still running in Pakistan, but with the industrial revolution in the world, the demand for a skilled labor force has also changed. ICT has revolutionized the international market, and the qualifications of teachers are now linked to ICT and TPACK. That is why there is a great need for new innovation in Pakistan.
ii. The results of the research will benefit educational policymakers, community members, and stakeholders alike.
iii. Research results will reveal new trends in teacher training.
iv. What skills does the trainer want the trainee to acquire so that the trainee can perform well in the field?
v. The results of the research will also prove to be very helpful for the teachers as they upgrade their skills with the new trends to meet the current and future educational challenges.

Procedure and Methodology of the Study

This research used a cross-sectional survey method; a five-point Likert scale took its data, five questions were asked on each factor, then the responses were put into SPSS, and a one-sample t-test was applied. These were considered positive perspectives; factors whose mean value was less than (3) were considered negative attitudes. Data were collected from 200 B.Ed., M.Ed.,

M.Phil., and Ph.D. education scholars from three South Punjab teacher education institutions using a convenience sampling technique. Before the data collection, a short lecture on the research objectives was given to prospective teachers, and each aspect was explained. The research objectives were described, such as how there is a demand for technological education in Pakistan and abroad and how we can make our students technical people through ICT and TPACK to earn suitable employment and meet the demand for skilled people in the modern market.

Population and Sampling of the Study

In this cross-sectional survey method research, 200 scholars of B.Ed., M.Ed., M.Phil., and Ph.D. education programs prospective teachers were selected using convenience sampling from three teacher training institutions in South Punjab. Thus, the study sample total was 200 perspectives.

Table 1 Sample of the study

The first stage for the selection of sample institutions		
Districts	Public Schools	PEF Schools
District Bahawalpur	The Islamia University Bahawalpur	
District Dera Ghazi Khan	Ghazi University D.G. Khan	
District Dera Ghazi Khan	University of Education Lahore D.G. Khan Campus	
Through the convenience sampling method, prospective teachers of B.Ed., M.Ed., M.Phil., and Ph.D. education were selected.		
Prospective teachers	200	
Total Sample		200

Data Collection and Analyses of Data

In this cross-sectional survey method research, using convenience sampling, data was collected from 200 prospective teachers of three teacher education institutions in South Punjab through a 5-point Likert scale. There were 35 questions related to perception, interest, and the importance of factors; each factor was analyzed through 5 questions; from these questions, the prospective teachers' perception of ICT was known through five questions. Similarly, five questions were asked about technological knowledge, five questions were asked about pedagogical knowledge, five questions were asked about content knowledge, and five questions were asked about technological pedagogical knowledge. Five questions were asked about pedagogical content knowledge, and five were about technological content knowledge. After collecting the data, data were entered into SPSS, and one sample t-test was applied; the factors above the mean value (3.0) were considered positive.

Remittances Review
April 2024,
Volume: 9, No: 2, pp.743-754
ISSN: 2059-6588(Print) | ISSN 2059-6596(Online)

Data Analysis and Findings

Table 2 Data analysis of the factors (one sample t-test)

Factors	Mean	Std. Deviation	t	df	Sig. (2-tailed)
ICT	3.6240	.54967	93.240	199	.000
TK	3.6630	.51259	101.061	199	.000
PK	3.3280	.56854	82.783	199	.000
CK	3.4380	.57148	85.079	199	.000
TPK	3.4900	.53416	92.399	199	.000
PCK	3.4170	.59505	81.210	199	.000
TCK	3.5830	.58448	86.694	199	.000

According to the results of the data analysis, all factors had excellent mean values (3.0 plus), which means all prospective teachers had positive attitudes and perceptions about ICT and TPACK. The mean value of Information and Communications Technology (ICT) was (3.6240) and $p< 0.05$, the mean value of Technological Knowledge (TK) was (3.6630) and $p< 0.05$, the mean value of Pedagogical Knowledge (PK) was (3.3280) and $p< 0.05$, the mean value of Content Knowledge (CK) was (3.4380) and $p< 0.05$, the mean value of Technological Pedagogical Knowledge (TPK) was (3.4900) and $p< 0.05$, the mean value of Pedagogical Content Knowledge (PCK) was (3.4170) and $p< 0.05$, and the mean value of Technological Content Knowledge (TCK) was (3.5830) and $p< 0.05$.

Discussion

It was found that in all factors, prospective teachers' perceptions were positive, and prospective teachers found positive towards ICT. Prospective teachers' perceptions and attitudes were found to be positive towards TPACK. The mean value of the factor Information and Communications Technology (ICT) was found to be better, and the results were significant. The mean value of Technological Knowledge (TK) was better, and teachers' perception and attitudes were found to be positive because the results were significant; the mean value of Pedagogical Knowledge (PK) was found positive, and the results were significant, the mean value of Content Knowledge (CK) found positive, and the results found significant, the mean value of Technological Pedagogical Knowledge (TPK) was higher, and the results were significant, the mean value of Pedagogical Content Knowledge (PCK) was highly positive and the results were significant, and the mean value of Technological Content Knowledge (TCK) found high and the results found significant. Overall, it was found that prospective teachers' perceptions and attitudes towards ICT and TPACK were positive, and they realized the importance of ICT and TPACK.

Conclusions

Prospective teachers' perceptions and attitudes towards ICT and TPACK were positive, with a higher mean value for ICT. Technological Knowledge (TK) was also positively perceived and influenced teachers' attitudes. Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), and Technological Content Knowledge (TCK) were all positively impacted. Overall, prospective teachers recognized the importance of ICT and TPACK.

Recommendations

Based on the findings and conclusions of the research, some recommendations are given below;

1. It is recommended that ICT and TPACK be included in the training of prospective teachers and that competent trainers who are well versed in ICT and TPACK be hired for the training.
2. The school and college level curriculum should also be integrated with ICT so that students can join the new educational revolution and compete positively with the world.

References

Abdurrahman, A., Nurulsari, N., Maulina, H., Rahman, B., Umam, R., & Jermsittiparsert, K. (2019). Multi-level scaffolding: A novel approach of physics teacher development program for promoting content knowledge mastery. *International Journal of Innovation, Creativity and Change*, *7*(8).

Abubakir, H., & Alshaboul, Y. (2023). Unravelling EFL teachers' mastery of TPACK: Technological pedagogical and content knowledge in writing classes. *Heliyon*, *9*(6).

Akour, M., & Alenezi, M. (2022). Higher education future in the era of digital transformation. *Education Sciences*, *12*(11), 784.

Ali, Z., Ahmad, N., Rehman, H. U., Ullah, N., & Zahra, T. (2023). Investigating Teacher Educators' Perceptions on Technology Integration in Teacher Preparation Programs. *Journal of Social Sciences Review*, *3*(2), 341-355.

Alwi, M., & Mumtahana, L. (2023). The Principal's Strategy in Improving the Quality of Teacher Performance in the Learning Process in Islamic Elementary Schools. *Kharisma: Jurnal Administrasi Dan Manajemen Pendidikan*, *2*(1), 66-78.

Angeli, C., & Valanides, N. (Eds.). (2014). *Technological pedagogical content knowledge: Exploring, developing, and assessing TPCK*. Springer.

Aslan, A., & Shiong, P. K. (2023). Learning in the Digital Age Full of Hedonistic Cultural Values Among Elementary School Students. *Bulletin of Pedagogical Research*, *3*(2), 94-102.

Brianza, E., Schmid, M., Tondeur, J., & Petko, D. (2024). The digital silver lining of the pandemic: The impact on preservice teachers' technological knowledge and beliefs. *Education and Information Technologies*, *29*(2), 1591-1616.

Cai, J., Hwang, S., Melville, M., & Robison, V. (2023). Theory for teaching and teaching for theory: Artifacts as tangible entities for storing and improving professional knowledge for teaching. In *Theorizing teaching: Current status and open issues* (pp. 225-251). Cham: Springer International Publishing.

Demissie, E. B., Labiso, T. O., & Thuo, M. W. (2022). Teachers' digital competencies and technology integration in education: Insights from secondary schools in Wolaita Zone, Ethiopia. *Social Sciences & Humanities Open*, *6*(1), 100355.

Erfan, F., Sulisyaningsih, S., & Syakur, A. (2023). Integration of ICT-Pedagogy for Senior High School Students: Pre-service Teachers' TPACK (Technological Pedagogical Content Knowledge). *Budapest International Research and Critics Institute-Journal (BIRCI-Journal)*, *5*(1).

Fannakhosrow, M., Nourabadi, S., Ngoc Huy, D. T., Dinh Trung, N., & Tashtoush, M. A. (2022). A comparative study of Information and Communication Technology (ICT)-based and conventional methods of instruction on learners' academic enthusiasm for L2 learning. *Education Research International*, *2022*.

Gerhard, K., Jäger-Biela, D. J., & König, J. (2023). Opportunities to learn, technological pedagogical knowledge, and personal factors of pre-service teachers: understanding the link between teacher education program characteristics and student teacher learning outcomes in times of digitalization. *Zeitschrift für Erziehungswissenschaft*, *26*(3), 653-676.

Gümüs, A. (2022). Twenty-first-century teacher competencies and trends in teacher training. *Educational theory in the 21st century: Science, technology, society and education*, 243-267.

Huang, H., Hwang, G. J., & Jong, M. S. Y. (2022). Technological solutions for promoting employees' knowledge levels and practical skills: An SVVR-based blended learning approach for professional training. *Computers & Education*, *189*, 104593.

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.

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK). *Contemporary issues in technology and teacher education*, *9*(1), 60-70.

Li, S., Liu, Y., & Su, Y. S. (2022). Differential analysis of teachers' technological pedagogical content knowledge (TPACK) abilities according to teaching stages and educational levels. *Sustainability*, *14*(12), 7176.

Madimbo, M. (2015). The power to change the world. *Elna Mouton Gertrude Kapuma Len Hansen*, 219.

Musarat, M. A., Irfan, M., Alaloul, W. S., Maqsoom, A., & Ghufran, M. (2023). A review on the way forward in construction through industrial revolution 5.0. *Sustainability*, *15*(18), 13862.

Mutiara, D. (2022). Teacher Competence In Industrial Revolution Era 4.0. *The Social Perspective Journal*, *1*(4), 259-266.

Nayazi, N., Khalid, P., & Perveen, M. (2023). Challenges and Opportunities in the Use of ICTs in education sector of Pakistan. *Life Science Journal*, *20*(1).

Phillips, M., & Harris, J. (2018, March). PCK and TPCK/TPACK: More than etiology. In *Society for Information Technology & Teacher Education International Conference* (pp. 2109-2116). Association for the Advancement of Computing in Education (AACE).

Prabawati, I., Riyanto, Y., Hariyati, N., Indrasetianingsih, A., & Ladiqi, S. (2023). Implementation of Learning Curriculum in Integrated Independent Campus Learning Program Case Study on KKNT Village Project. *International Journal of Learning, Teaching and Educational Research*, *22*(3), 470-490.

Schiering, D., Sorge, S., Tröbst, S., & Neumann, K. (2023). Course quality in higher education teacher training: What matters for pre-service physics teachers' content knowledge development? *Studies in Educational Evaluation*, *78*, 101275.

Şen, M. (2023). Suggestions for the analysis of science teachers' pedagogical content knowledge components and their interactions. *Research in Science Education*, *53*(6), 1081-1095.

Siddiqui, G. K., Ali, M. S. Z., Zarar, N., Asghar, S., & Munir, H. (2023). Public Education System in Pakistan: An Exploration into Major Problems. *Journal of Positive School Psychology*, 1311-1323.

Snezhko, Z., Babaskin, D., Vanina, E., Rogulin, R., & Egorova, Z. (2022). Motivation for Mobile Learning: Teacher Engagement and Built-In Mechanisms. *International Journal of Interactive Mobile Technologies*, *16*(1).

Sulthani, D. A., & Thoifah, I. (2022). Urgency of Stakeholders in Improving the Quality of Education. *Riwayat: Educational Journal of History and Humanities*, *5*(2), 443-451.

Tahir, J., & Farooq, F. A. (2023). Globalization and Pakistan Educational System in 21st Century: Challenges and Proposed Action Plan. *Al-Mithaq (Research Journal of Islamic Theology)*, *2*(02), 18-33.

Tanjung, S. (2022). Problem based learning (PBL) model with technological, pedagogical, and content knowledge (TPACK) approach. *International Journal of Education in Mathematics, Science and Technology*, *10*(3), 740-752.

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.

Varas, D., Santana, M., Nussbaum, M., Claro, S., & Imbarack, P. (2023). Teachers' strategies and challenges in teaching 21st century skills: Little common understanding. *Thinking Skills and Creativity*, *48*, 101289.

Yang, W., Luo, H., & Su, J. (2022). Towards inclusiveness and sustainability of robot programming in early childhood: Child engagement, learning outcomes and teacher perception. *British Journal of Educational Technology*, *53*(6), 1486-1510.

Zeng, Y., Yang, W., & Bautista, A. (2023). Teaching programming and computational thinking in early childhood education: a case study of content knowledge and pedagogical knowledge. *Frontiers in Psychology*, *14*, 1252718.

Zhang, C., Khan, I., Dagar, V., Saeed, A., & Zafar, M. W. (2022). Environmental impact of information and communication technology: Unveiling the role of education in developing countries. *Technological Forecasting and Social Change*, *178*, 121570.

Zhang, J., & Chen, Z. (2023). Exploring human resource management digital transformation in the digital age. *Journal of the Knowledge Economy*, 1-17.