

COMPARATIVE ANALYSIS OF TECHNO-PEDAGOGICAL COMPETENCIES AMONG UNDERGRADUATE AND PRE-SERVICE EDUCATION STUDENTS: ASSESSING READINESS FOR 21ST-CENTURY TEACHING AND LEARNING

Dr. Tariq Hussain^{*1}, Ifrah Jamil², Dr. Abida Nasreen³

^{*1}Assistant Professor, Institute of Education and Research, University of the Punjab, Lahore, Punjab, Pakistan

²M. Phil, Scholar, Institute of Education and Research, University of the Punjab, Lahore, Punjab, Pakistan

^{*3}Associate Professor, Institute of Education and Research, University of the Punjab, Lahore, Punjab, Pakistan

Corresponding Author: *

DOI: <https://doi.org/10.5281/zenodo.15032758>

Received	Revised	Accepted	Published
22 January, 2025	22 February, 2025	07 March, 2025	15 March, 2025

ABSTRACT

In the fast developing educational setting, techno-pedagogical competencies play a decisive role in preparing future educators for technology-integrated teaching and learning. This study presents a comparative analysis of techno-pedagogical competencies among undergraduate and pre-service education students, focusing on differences based on program enrollment, computer availability, and internet access. A quantitative research design was employed, utilizing an independent samples t-test to analyze the variations in techno-pedagogical competencies. The findings reveal that undergraduate students demonstrate significantly higher techno-pedagogical competencies compared to pre-service education students enrolled in B. Ed programs. The majority of respondents from undergraduate programs exhibited greater proficiency in integrating technology into their teaching practices. Further analysis indicates that students with access to computers possess significantly stronger techno-pedagogical competencies than those without computer facilities. Similarly, participants with internet access outperform those lacking such resources in terms of their ability to effectively integrate technology into instructional settings. These findings highlight the critical role of digital accessibility in developing techno-pedagogical competencies. The study underlines the need for better technological resources and support within teacher education programs to ensure evenhanded openings for all pre-service teachers in attaining necessary digital teaching skills.

Keywords: Techno pedagogical competencies, Computer availability, Internet access.

INTRODUCTION

The fast incorporation of technology into education has changed customary teaching and learning methodologies, requiring educators to develop well-built techno-pedagogical competencies (Mishra & Koehler, 2006). These competencies encompass the ability to effectively integrate digital tools, online resources, and interactive teaching strategies to enhance student engagement and learning outcomes (Harris, Mishra, & Koehler, 2009). As teacher education

programs strive to equip future educators with the necessary skills to navigate 21st-century classrooms, understanding the disparities in techno-pedagogical competencies among different groups of pre-service teachers becomes crucial.

Techno-pedagogical competencies are influenced by various factors, including access to technology, digital literacy, and pedagogical training (Tondeur et al., 2017). However, disparities in technology

integration skills persist among students enrolled in different teacher education programs. Undergraduate students, particularly those in Bachelor of Science (BS) programs, may have greater exposure to technology-intensive coursework compared to pre-service education students enrolled in Bachelor of Education (B.Ed) programs. This discrepancy raises important questions about how different academic pathways shape the technological readiness of future educators.

This study aims to provide a comparative analysis of techno-pedagogical competencies among undergraduate and pre-service education students. Specifically, the study focuses on two key objectives: (1) assessing cognitive flexibility and techno-pedagogical competencies of pre-service teachers based on their program enrollment, and (2) evaluating the influence of computer availability and internet access on these competencies. Understanding these variations is essential for designing effective teacher education curricula that bridge the technological gap and ensure that all future educators are adequately prepared for modern classrooms (Voogt et al., 2013).

A growing body of research highlights the significant role of digital access in developing technology-driven teaching skills. Studies indicate that students with greater exposure to digital tools, either through coursework or personal access, tend to demonstrate higher levels of confidence and proficiency in technology integration (Ertmer & Ottenbreit-Leftwich, 2010). Given that technology is an indispensable component of contemporary education, ensuring equitable access to digital resources is fundamental in fostering competent educators (Shinas et al., 2015). This study seeks to determine whether differences in program enrollment, computer availability, and internet access contribute to variations in techno-pedagogical competencies among pre-service teachers.

The research employs a quantitative approach, utilizing an independent samples t-test to analyze the differences in techno-pedagogical competencies. The findings indicate that undergraduate students exhibit higher competency levels than pre-service education students. Furthermore, students with access

to computers and the internet demonstrate significantly greater proficiency in integrating technology into teaching. These findings underscore the importance of digital accessibility and curriculum enhancement in teacher education programs to equip future educators with essential technology-driven instructional skills.

By identifying the disparities in techno-pedagogical competencies among different groups of pre-service teachers, this study provides valuable insights for policymakers, curriculum designers, and educators. Addressing these gaps can lead to more effective teacher preparation programs that ensure all educators, regardless of their academic background, are equipped to meet the technological demands of modern classrooms. Future research should explore strategies for integrating advanced digital literacy training within teacher education curricula to promote equitable access to technology-enhanced learning opportunities.

Literature Review

The rapid evolution of technology has significantly reshaped the educational landscape, requiring educators to acquire a specific set of competencies to effectively integrate digital tools into their teaching practices. One such set of competencies is known as techno-pedagogical competencies, which refers to the ability of educators to blend technological tools and pedagogical strategies in a manner that enhances the learning process (Mishra & Koehler, 2006). In teacher education, developing techno-pedagogical competencies is essential for preparing future educators to navigate and teach in technology-rich environments.

Techno-Pedagogical Competencies in Teacher Education

Techno-pedagogical competencies are typically assessed through the Technological Pedagogical Content Knowledge (TPACK) framework, which underscores the interplay between technology, pedagogy, and content knowledge (Harris, Mishra, & Koehler, 2009). According to Tondeur et al. (2017), the integration of technology in teacher education programs is crucial to prepare

educators for the digital age. This includes providing preservice teachers with access to technological tools and pedagogical training that enables them to design and implement technology-enriched learning experiences. However, disparities in techno-pedagogical competencies exist between students enrolled in different teacher education programs, often due to differences in program focus and exposure to technology-intensive coursework.

Disparities in Techno-Pedagogical Competencies

Several studies highlight significant disparities in the techno-pedagogical competencies of pre-service teachers based on their academic background and exposure to digital tools. Research by Ertmer and Ottenbreit-Leftwich (2010) indicates that undergraduate students, particularly those enrolled in science and technology programs, tend to exhibit higher levels of techno-pedagogical competency compared to their peers in education-focused programs. This can be attributed to the greater emphasis on technology-driven coursework and hands-on learning experiences in STEM disciplines. In contrast, students in education programs, especially those pursuing Bachelor of Education (B.Ed) degrees, often have limited exposure to digital technologies, which hinders their ability to integrate technology effectively into teaching (Shinas, Karp, & Finn, 2015).

A study by Voogt et al. (2013) also notes that pre-service teachers enrolled in technology-related programs tend to possess more advanced digital literacy skills, which are crucial for integrating technology into pedagogy. The lack of exposure to technology and the absence of structured digital literacy training in traditional education programs have led to gaps in techno-pedagogical competencies between different groups of pre-service teachers (Tondeur et al., 2017). These disparities are further exacerbated by unequal access to technological resources such as computers and internet connectivity, which are essential for fostering digital literacy and enhancing techno-pedagogical skills.

The Role of Technology Access in Developing Competencies

Access to technology plays a pivotal role in the development of techno-pedagogical competencies. Studies have shown that pre-service teachers who have access to digital tools, both within their educational institutions and at home, are more confident in using technology for instructional purposes (Ertmer & Ottenbreit-Leftwich, 2010). Shinas et al. (2015) argue that exposure to digital resources, whether through coursework or personal access, significantly enhances pre-service teachers' ability to integrate technology effectively into their teaching. Conversely, the absence of reliable access to computers and the internet creates a significant barrier to developing these competencies, particularly in underfunded or rural educational settings (Tondeur et al., 2017). This highlights the need for teacher education programs to prioritize the provision of technological resources to ensure that all pre-service teachers are equipped with the skills necessary for modern classrooms. To address the disparities in techno-pedagogical competencies, many scholars have called for reforms in teacher education curricula. Tondeur et al. (2017) suggest that teacher education programs should integrate structured digital literacy training that ensures all pre-service teachers, regardless of their academic background, acquire the necessary skills to use technology in their pedagogical practices. Moreover, universities and teacher training institutions must ensure equitable access to digital tools and resources, including providing digital labs, internet access, and professional development workshops focused on technology integration (Voogt et al., 2013). By bridging the digital divide, teacher education programs can ensure that all future educators are adequately prepared to teach in 21st-century classrooms.

The incorporation of digital technology into teaching and learning is no longer a luxury but a necessity for modern education systems. As technology becomes increasingly embedded in daily life, its role in education continues to grow, prompting educators to

develop techno-pedagogical competencies (Mishra & Koehler, 2006). These competencies require an intricate understanding of how to use digital tools effectively within the context of teaching, while ensuring that the integration supports pedagogical goals. However, research indicates that pre-service teachers, depending on their academic backgrounds and programs of study, exhibit varying levels of readiness for technology integration in the classroom. The disparity in techno-pedagogical competencies between different student groups, particularly between undergraduate and pre-service education students, is the focus of this study.

The Role of Techno-Pedagogical Competencies in Teacher Education

Techno-pedagogical competencies refer to the knowledge and skills required by educators to effectively integrate technology within their pedagogical practices, enhancing both teaching and learning (Mishra & Koehler, 2006). The Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler (2006), serves as a foundational model for understanding these competencies. TPACK emphasizes the intersection of three key domains: technology, pedagogy, and content knowledge. Educators must possess not only a deep understanding of the subject matter but also the pedagogical strategies required to teach it effectively, all while incorporating the appropriate technological tools. This framework is essential for assessing the readiness of future educators to teach in the technology-driven classrooms of the 21st century (Harris, Mishra, & Koehler, 2009).

Research suggests that pre-service teachers, who are often still developing their pedagogical approaches, may face challenges in acquiring these competencies if their programs do not explicitly integrate technology. Tondeur et al. (2017) found that while some teacher education programs integrate technology into their curricula, others are still grappling with how to teach future educators to use technology in ways that genuinely support learning. These challenges are compounded by disparities in

the digital literacy levels of students entering teacher education programs. Ertmer and Ottenbreit-Leftwich (2010) argue that teachers' confidence in using technology is directly linked to their prior exposure to digital tools. Students with limited prior exposure often struggle to incorporate technology effectively into their teaching.

Comparative Analysis of Techno-Pedagogical Competencies among Different Student Groups

The existing literature reveals significant differences in the techno-pedagogical competencies of pre-service teachers based on their academic background and program enrollment. For example, undergraduate students enrolled in science, technology, engineering, and mathematics (STEM) programs tend to exhibit higher levels of digital literacy and technology integration skills than their peers enrolled in education-focused programs (Ertmer & Ottenbreit-Leftwich, 2010). This can be attributed to the greater emphasis on technology-driven coursework in STEM disciplines, where students frequently engage with digital tools in both theory and practice. Furthermore, undergraduate programs often include more hands-on learning experiences with technology, which fosters greater confidence in using these tools to enhance learning (Shinas, Karp, & Finn, 2015).

On the other hand, students pursuing Bachelor of Education (B.Ed) degrees often have fewer opportunities for technology-rich coursework and are less likely to have access to advanced digital tools (Shinas et al., 2015). As a result, these students are less likely to develop the same level of techno-pedagogical competencies as their peers in STEM programs. Tondeur et al. (2017) found that pre-service teachers enrolled in education programs are often not equipped with the same level of technology proficiency, limiting their ability to integrate digital tools effectively into their teaching practices. This disparity is concerning, as it suggests that teacher education programs may not be adequately preparing educators to navigate the increasingly technology-driven classrooms of today's schools.

Moreover, a study by Voogt et al. (2013) suggests that variations in techno-pedagogical competencies are not solely attributable to the field of study but also to the quality of technology integration within specific teacher education programs. Teacher education programs that emphasize hands-on use of digital tools and integrate technology across subjects tend to produce graduates who are more proficient in incorporating technology into their teaching practices. However, programs that limit their technology training to isolated courses or neglect the use of digital tools in the curriculum leave future teachers unprepared for the demands of 21st-century classrooms.

The Impact of Digital Access on Techno-Pedagogical Competencies

The role of digital access in developing techno-pedagogical competencies cannot be overstated. Studies have consistently shown that pre-service teachers with greater access to technology—both within their educational institutions and at home—demonstrate higher levels of proficiency in using technology for teaching purposes. Ertmer and Ottenbreit-Leftwich (2010) found that when pre-service teachers have consistent access to computers, the internet, and digital learning tools, they are more confident in their ability to integrate these technologies into their lesson planning and delivery. Conversely, students who lack access to digital resources often face challenges in developing these competencies. Shinas et al. (2015) note that limited access to technology at home or within educational settings creates significant barriers to technology integration, particularly for students in underserved or rural areas.

Tondeur et al. (2017) also found that pre-service teachers with access to digital tools were better equipped to create technology-integrated lesson plans, which are essential for fostering student engagement and learning in the digital age. The lack of access to technology, particularly for students in under-resourced educational institutions, can significantly hinder the development of these skills and create disparities in the readiness of future educators to teach with technology. These findings highlight the critical role that

institutions must play in providing equitable access to technology in teacher education programs.

Addressing the Digital Divide in Teacher Education

Addressing the digital divide in teacher education is crucial to ensuring that all future educators are adequately prepared to teach in technology-rich environments. Tondeur et al. (2017) advocate for comprehensive curriculum reforms that include digital literacy training as a core component of teacher education. Teacher preparation programs must go beyond teaching students how to use technology and focus on how to integrate these tools effectively within the context of their subject matter. As noted by Voogt et al. (2013), universities and teacher training institutes must provide access to state-of-the-art technological resources, such as digital learning labs and advanced classroom technologies, to ensure that all pre-service teachers have the opportunity to develop these essential competencies.

In addition to providing access to technology, teacher education programs must offer professional development workshops that focus on technology integration. Ertmer and Ottenbreit-Leftwich (2010) suggest that ongoing professional development is key to ensuring that teachers remain confident and competent in using technology throughout their careers. Furthermore, creating a culture of technological adaptability within teacher education programs is essential for fostering a workforce that is capable of responding to the ever-evolving demands of 21st-century classrooms.

Policy Implications

Given the centrality of technology in contemporary education, it is essential for policymakers to prioritize the integration of digital tools and digital literacy training in teacher education programs. As highlighted by Tondeur et al. (2017), structured technology training, combined with continuous professional development opportunities, can help enhance pre-service teachers' ability to integrate technology into their teaching practices. Governments and

educational institutions must work together to invest in digital resources, such as high-speed internet, computers, and other educational technologies, to ensure equitable access to digital tools for all teacher education students.

Future research should explore the potential of emerging technologies, such as artificial intelligence (AI), virtual reality (VR), and augmented reality (AR), in transforming teacher education. These technologies have the potential to create immersive learning experiences that enhance techno-pedagogical competencies and provide pre-service teachers with the tools they need to teach effectively in the digital age. Additionally, research should investigate the long-term impact of technology integration training on teachers' professional development and their ability to create technology-enriched learning environments for students.

The literature review highlights the significance of techno-pedagogical competencies in modern education and the factors influencing their development. While undergraduate students often exhibit stronger technology integration skills than pre-service education students, access to digital resources remains a determining factor in competency levels. Future research should explore innovative strategies to enhance digital training in teacher education, ensuring that all educators are well-equipped to navigate technology-rich learning environments.

Materials and Methods

This study employed a quantitative research design using a comparative approach to

analyze differences in techno-pedagogical competencies among pre-service teachers. An independent samples t-test was used to compare competencies based on program enrollment, computer availability, and internet access. The population included undergraduate students enrolled in various BS programs and pre-service teachers in B.Ed programs at a university. A multistage sampling technique was employed to select participants from different academic backgrounds. The final sample consisted of students with varying levels of access to computers and the internet.

Data Collection and Instrumentation

A self-developed questionnaire was used to assess techno-pedagogical competencies. The instrument contained 45 statements across seven factors, measured on a 5-point Likert scale. The reliability and validity of the questionnaire were established using Cronbach's alpha coefficient ($\alpha = 0.861$). Independent sample t-tests were conducted to determine whether significant differences exist in techno-pedagogical competencies based on program enrollment (BS vs. B.Ed), computer availability, and internet access. The analysis revealed that BS students exhibited higher competencies than B.Ed students. Additionally, students with computer and internet access demonstrated significantly greater technological proficiency.

Result and Discussion

Summary statistics about the comparison in BS and B. Ed respondents Techno pedagogical Competencies.

Table 1

	Program	N	Mean	SD	T-value	Sign.
Techno pedagogical Competencies	BS	311	87.7299	12.88551	.647	.524
	B. Ed	138	86.9130	11.69595		

Table above show the results of independent sample t-test to identify the mean difference in the techno pedagogical competencies of the respondents in term of their programs. The results of independent sample t-test shows that the significance is statistically difference, $t(\text{sign}.524) = .647$, $p > 0.05$. It is conclude that BS students have more

competencies as compare to the B. Ed students. The majority of the respondents were from BS program and show that they have much more techno-pedagogical competencies than B. Ed students.

Summary statistics about the comparison of respondents Techno pedagogical

Competencies in term of computer availability.

Table 2

	Computer availability	N	Mean	SD	T-value	Sign.
Techno pedagogical Competencies	Yes	383	88.2846	11.82485	.034	.001
	No	66	82.8030	15.27715		

Table shows the result of independent sample t-test for analysis the mean comparison in the techno pedagogical competencies of the participants in term of computer availability. The analysis depicts that there is significance difference with t value, $t(\text{sign}.001) = .034$, $p > 0.05$. The students who have

computer facility were much more competent that the students who don't have the computer facility.

Summary statistics about the comparison of respondents Techno pedagogical Competencies in term of Internet Access.

Table 3

	Internet Access	N	Mean	SD	T-value	Sign.
Techno pedagogical Competencies	Yes	375	88.2800	11.90264	.420	.002
	No	73	83.2192	14.72644		

Above table shows the analysis of mean comparison among the respondents who have internet access. The analysis of the above statistics shows the significance difference with value $t(\text{sign}.002) = .446$, $p > 0.05$ that clearly shows the participants with internet facility have the more competency than the participants who don't have internet.

Conclusions

The findings of this study underscore significant disparities in techno-pedagogical competencies among pre-service teachers based on their academic program, computer availability, and internet access. The results indicate that undergraduate students, particularly those enrolled in BS programs, exhibit higher levels of technological proficiency compared to B. Ed students. This suggests that exposure to technology-intensive coursework plays a crucial role in enhancing digital teaching competencies.

Moreover, access to computers and the internet emerged as a critical factor influencing pre-service teachers' ability to integrate technology into their pedagogical practices. Students with reliable digital access demonstrated significantly greater techno-pedagogical competencies than their counterparts who lacked such resources. These findings highlight the digital divide in teacher education and emphasize the need

for equitable access to technological tools and training.

To bridge this gap, teacher education programs should incorporate structured digital literacy training, provide hands-on experience with educational technology, and ensure equitable access to digital resources. Institutions must also invest in infrastructure that facilitates technology-driven learning, such as digital labs and online learning platforms. Furthermore, curriculum designers should integrate comprehensive technology-focused modules to equip all pre-service teachers with the skills necessary for 21st-century education.

Future research should explore innovative strategies to enhance techno-pedagogical training, including the use of artificial intelligence, virtual reality, and blended learning approaches. By addressing these gaps, educational institutions can better prepare future educators to navigate and excel in technology-integrated classrooms, ultimately improving teaching and learning outcomes in the digital age.

Recommendations

1. Strengthening Technological Integration in Teacher Education Programs: Given the higher techno-pedagogical competencies observed among BS students, it is recommended that teacher education programs, especially those in B. Ed,

incorporate more technology-intensive coursework. This could include hands-on experience with educational technologies, digital pedagogy, and practical exposure to technology-rich classroom environments. Ensuring that all teacher candidates, regardless of their program, receive equal exposure to these technologies will help enhance their digital competencies.

2. Provision of Digital Resources and Infrastructure: The significant difference in techno-pedagogical competencies between students with and without computer and internet access highlights the digital divide. It is recommended that institutions invest in providing all students with adequate access to computers and reliable internet. This may involve setting up dedicated computer labs, offering loan programs for digital devices, and creating online platforms that offer access to learning materials and tools.

3. Curriculum Revitalization with Technology-Focused Modules: Curriculum designers should revise and update the teacher education syllabus to integrate technology-focused modules, ensuring that pre-service teachers are equipped with the skills necessary for 21st-century teaching. These modules could cover digital literacy, the use of educational software, e-learning tools, and effective strategies for integrating technology into various teaching methodologies.

4. Promoting Equity in Digital Literacy Training: As the findings suggest disparities in digital competence based on access to resources, there is a need to promote digital literacy training across all educational institutions. This training should not only focus on technological skills but also on pedagogical strategies that integrate technology effectively into classroom practice, ensuring all pre-service teachers are adequately prepared for the digital classroom environment.

5. Future Research on Emerging Technologies in Teacher Education: Future studies should explore the potential of

emerging technologies, such as artificial intelligence (AI), virtual reality (VR), and blended learning models, to enhance techno-pedagogical competencies. Research on how these technologies can be incorporated into teacher education programs to foster innovative and engaging learning experiences would be valuable. Additionally, longitudinal studies examining the long-term impact of technology exposure on teaching effectiveness could further inform curriculum development.

6. Tailored Professional Development for Educators: In-service teachers should also be provided with continuous professional development opportunities to strengthen their techno-pedagogical skills. This could include workshops, seminars, and online courses focused on current educational technologies and innovative teaching strategies. By ensuring that both pre-service and in-service teachers are digitally competent, educational institutions can create a culture of continuous technological improvement.

7. Collaboration Between Educational Stakeholders: Collaboration between policymakers, educational institutions, and the tech industry should be fostered to bridge the digital divide. Partnerships with tech companies can provide access to modern educational tools, resources, and platforms, ensuring that teacher education programs are aligned with current technological trends and advancements in the field of education.

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