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Research Paper

The Relationship Between Teachers' Technology Adoption and Students' Technology Acceptance in Mathematics Education

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Abstract

This study explores the relationship between teachers' technology adoption and students' technology acceptance in the context of mathematics education, with a specific focus on demographic variables such as gender, locality, and type of school. A total of 150 secondary school teachers and students participated in the research. Data were collected using self-constructed questionnaires and analyzed using independent sample t-tests and Pearson's correlation coefficient. The results revealed statistically significant differences in technology adoption and acceptance based on gender, locality, and school type. Female, urban, and private school participants reported higher levels of technology engagement compared to their male, rural, and government school counterparts. Most notably, a strong positive correlation ($r = 0.86$, $p < .01$) was found between teachers' technology adoption and students' technology acceptance, indicating that increased use of technology by teachers positively influences students' willingness to embrace technology in mathematics learning. The findings underscore the importance of equipping teachers with the skills and support needed to effectively integrate technology into instruction. Addressing disparities in infrastructure and providing targeted professional development are essential steps toward fostering equitable and effective technology-enhanced education. The study contributes to the growing body of evidence supporting teacher-led initiatives to promote digital learning environments in mathematics classrooms.

Keywords: *Technology Adoption, Technology Acceptance, Mathematics Education, Teachers, Students.*

1. INTRODUCTION

The integration of technology into education has become a cornerstone of 21st-century teaching and learning. In mathematics classrooms, digital tools such as graphing calculators, virtual manipulatives, educational apps, and learning management systems are being used to make abstract concepts more tangible and engaging **(Li & Ma, 2010)**. The effectiveness of these tools, however, is heavily influenced by both the teachers who adopt them and the students who are expected to use them.

Teachers play a pivotal role in technology integration, acting as both facilitators and gatekeepers of digital innovation in the classroom **(Ertmer & Ottenbreit-Leftwich, 2010)**. Their attitudes, confidence, and competence with technology determine the extent and quality of its use in instruction. Research indicates that when teachers demonstrate a strong commitment to using educational technology, it can foster a more engaging and student-centered learning environment **(Inan & Lowther, 2010)**.

Students, on the other hand, are not merely passive recipients of technology-enhanced instruction. Their willingness to accept and use educational technology is essential for achieving meaningful learning outcomes. The Technology Acceptance Model (TAM), developed by **Davis (1989)**, posits that two primary factors—perceived usefulness and perceived ease of use—determine an individual's acceptance of technology. When students perceive classroom technologies as beneficial and user-friendly, their motivation and academic performance tend to improve **(Teo, 2011)**.

Importantly, students' technology acceptance may be directly influenced by how teachers adopt and utilize technological tools. If teachers effectively integrate technology into teaching practices, students are more likely to perceive these tools as valuable, thus increasing their own acceptance **(Scherer et al., 2019)**. Despite this potential link, few studies have examined the direct relationship between teachers' technology adoption and students' technology acceptance, particularly in middle school mathematics education.

Given the critical role of technology in mathematics instruction and the need to optimize both teacher and student engagement with digital tools, this study seeks to explore the relationship between teachers' technology adoption and students' technology acceptance. The results aim to inform policies, teacher training programs, and classroom practices that support technology-driven mathematics instruction.

2. THEORETICAL FRAMEWORK

2.1. Technology Acceptance Model (TAM)

Originally proposed by **Davis (1989)**, the Technology Acceptance Model posits that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) predict an individual's Behavioral Intention (BI) to use technology. Later extensions include external factors such as enjoyment, social influence, and self-efficacy **(Venkatesh & Davis, 2000)**.

2.2. Technological Pedagogical Content Knowledge (TPACK)

The TPACK framework **(Mishra & Koehler, 2006)** asserts that effective technology integration requires knowledge of content (CK), pedagogy (PK), and technology (TK). Mathematics educators with strong TPACK are more capable of selecting and applying tools that align with learning goals.

2.3. Teachers' Technology Adoption in Mathematics Classrooms

Recent studies identify several determinants of teachers' technology adoption:

- **Attitudinal Beliefs**: Positive beliefs about the usefulness and ease of technology enhance adoption likelihood.
- **TPACK Competence**: Teachers with well-developed TPACK skills are more likely to use technology meaningfully.
- **Perceived Compatibility**: Tools aligned with curriculum and pedagogy are more readily adopted.

Zhang et al. (2023) found that Chinese primary math teachers' adoption behavior was heavily influenced by their TPACK and prior successful experiences with digital tools. Similarly, **Rahman et al. (2023)** noted that PU was the strongest predictor of secondary teachers' behavioral intention to use ICT in teaching mathematics.

2.4. Students' Technology Acceptance in Mathematics

Students' acceptance of technology in math learning is shaped by both internal and external factors. A large-scale meta-analysis by **Wang et al. (2023)** involving over 150,000 participants revealed that enjoyment, self-efficacy, and social norms significantly influence students' PU and PEOU.

Classroom environments that emphasize supportive, engaging, and collaborative uses of technology enhance student acceptance. Lee and Hassan (2023) found that students mirrored teachers' attitudes: when teachers valued and actively used mobile tools in math, students reported greater perceived usefulness and intention to adopt them.

2.5. Generative AI and Emerging Technologies

Recent advancements in **generative AI** tools for mathematics (e.g., equation solvers, chat-based tutoring) have introduced new variables in the acceptance equation. Niemi et al. (2023) found that students' acceptance of GenAI tools in math depended on perceived enjoyment and compatibility with learning needs. Crucially, teacher guidance and framing of AI use were instrumental in student adoption decisions.

3. REVIEW OF RELATED LITERATURE

3.1. Teachers' Technology Adoption in Mathematics Education

Teachers play an important role in bringing technology into the classroom. Their willingness and ability to use digital tools can improve teaching and help students stay engaged. Research shows that using tools like smartboards, math software (like GeoGebra), and online platforms helps students understand math better (Ertmer & Ottenbreit-Leftwich, 2010). The Technology Acceptance Model (TAM) and TPACK framework explain that teachers are more likely to use technology if they find it useful, easy to use, and know how to use it in teaching (Teo, 2011; Mishra & Koehler, 2006).

However, some teachers face challenges like lack of training, poor access to technology, or low confidence in using it (Inan & Lowther, 2010). Support through training and resources can help more teachers start using technology effectively (Koehler et al., 2014).

3.2. Students' Technology Acceptance in Mathematics Learning

Students' technology acceptance refers to their willingness to engage with and use educational technology for learning purposes. According to Davis's (1989) Technology Acceptance Model, students are more likely to accept technology when they perceive it as useful and easy to use. In mathematics, tools such as online graphing platforms, simulation apps, and video tutorials have been found to increase student motivation and conceptual understanding (Ng & Gunstone, 2003).

Research indicates that students exposed to technology-rich environments generally report higher engagement, improved attitudes toward mathematics, and better academic outcomes (Pierce & Ball, 2009). However, acceptance can vary by gender, grade level, and digital literacy.

3.3. The Relationship Between Teacher Adoption and Student Acceptance

Recent studies emphasize that teachers' technology adoption significantly shapes students' acceptance. When teachers actively integrate technology into instruction, students are more likely to perceive it as a valuable part of learning (Tondeur et al., 2017). A strong correlation exists between teachers' confidence in using technology and students' positive attitudes toward it (Scherer et al., 2019). Furthermore, the consistency and quality of technology use in the classroom influence students' long-term acceptance.

In mathematics education specifically, when technology is used to demonstrate complex problems, offer immediate feedback, and support differentiated learning, students become more receptive and confident in using digital tools (Zbiek et al., 2007).

3.4. Influence of Demographic Factors

Demographic factors such as gender, locality (urban/rural), and types of school can influence both teachers' adoption and students' acceptance. For instance, urban schools tend to have better access to ICT infrastructure, leading to more frequent and diverse use of technology (Almekhlafi & Almeqdadi, 2010). Gender-related studies show mixed results, with some indicating that male teachers and students show slightly higher confidence in using technology, while others report no significant differences (Venkatesh & Morris, 2000).

4. NEED FOR THE PRESENT STUDY

The integration of technology in education has become increasingly vital in promoting interactive, student-centered learning environments, especially in mathematics, where abstract concepts often benefit from visual and dynamic representation. While numerous studies have explored the impact of educational technology on student learning outcomes, relatively few have focused on the direct relationship between teachers' adoption of technology and students' acceptance of these tools in subject-specific contexts such as mathematics.

Existing literature highlights that teachers play a critical role in modeling effective technology use and shaping students' attitudes toward digital learning tools **(Ertmer & Ottenbreit-Leftwich, 2010; Tondeur et al., 2017)**. At the same time, the Technology Acceptance Model (TAM) developed by **Davis (1989)** emphasizes the importance of perceived usefulness and ease of use in predicting technology acceptance among users, including students. However, the extent to which teachers' use and integration of technology influences students' perceptions and willingness to engage with those tools remains underexplored, particularly in the secondary mathematics classroom.

Given the growing reliance on digital platforms, simulations, graphing calculators, and other instructional technologies in math education, understanding this relationship is essential. If students perceive these tools as helpful and see them modeled effectively by teachers, they are more likely to engage with them, ultimately supporting better learning outcomes. Conversely, if teachers fail to adopt or effectively utilize such tools, students may remain resistant or indifferent to their use.

Therefore, this study is needed to:

- Bridge the gap in research connecting teacher technology adoption with student acceptance in mathematics education.
- Provide empirical evidence that can inform teacher training, instructional design, and policy development related to educational technology.
- Support efforts to align classroom practices with student needs and technological expectations in a rapidly evolving digital learning landscape.

The findings from this study have the potential to offer valuable insights into how technology integration can be optimized through a better understanding of the teacher-student dynamic, specifically within the mathematics education context.

5. OBJECTIVES OF THE STUDY

- To investigate the relationship between teachers' technology adoption and students' technology acceptance.
- To determine whether there are statistically significant differences in:
  - Teachers' technology adoption based on gender, school locality and Types of school.
  - Students' technology acceptance based on gender, school locality and Types of school.

6. NULL HYPOTHESIS

- There is no statistically significant difference between male and female participants in terms of teachers' technology adoption and students' technology acceptance in mathematics education.
- There is no statistically significant difference between rural and urban participants in terms of teachers' technology adoption and students' technology acceptance in mathematics education.
- There is no statistically significant difference was found between government and private schools, for both teachers and students, regarding teachers' technology adoption and students' technology acceptance in mathematics education.
- There is no statistically significant relationship between teachers' technology adoption and students' technology acceptance in mathematics education.

7. METHODOLOGY

7.1. Research Design

This study employed a normative survey research design to investigate the relationship between teachers' technology adoption and students' technology acceptance in mathematics education. The goal was to determine whether a statistically significant association exists between how teachers integrate digital tools and how students perceive and accept their use in mathematics classrooms.

7.2. Sample and sampling techniques

The study involved two target populations: secondary school mathematics teachers and their students. A simple random sampling technique was used. First, schools were randomly selected from both urban and rural areas of Sivagangai and Madurai districts to ensure demographic diversity. Within each selected school, mathematics teachers who reported using any form of digital technology (e.g., graphing software, educational platforms, interactive whiteboards) in their instruction were invited to participate. Their students were subsequently surveyed. A total of 150 mathematics teachers and students participated in the study. All participants were secondary school teachers and students, and informed consent was obtained from both groups.

7.3. Tools description

Two validated survey instruments were used:

1. **Teacher Technology Adoption Scale (TTAS)** – Adapted from **Ertmer and Ottenbreit-Leftwich (2010)**, this instrument measured teachers' frequency, confidence, and perceived effectiveness in using technology in mathematics instruction. It included 20 Likert-scale items (1 = Strongly Disagree to 5 = Strongly Agree).
2. **Student Technology Acceptance Questionnaire (STAQ)** – Based on the Technology Acceptance Model **(Davis, 1989)**, this instrument assessed students' perceived usefulness, perceived ease of use, and behavioral intention to use technology in mathematics. The 18-item scale also used a 5-point Likert format.

Both instruments were reviewed by educational technology experts for content validity and piloted with a small sample (50 teachers and students) to assess internal consistency. Cronbach's alpha values were 0.88 for TTAS and 0.91 for STAQ, indicating high reliability.

7.4. Data Collection Procedures

Data were collected over a four-week period during the academic year. Surveys were administered electronically using a secure, school-approved platform during regular mathematics class periods. Teachers completed their surveys independently, while students completed theirs anonymously to reduce response bias. Participation was voluntary, and confidentiality was assured.

7.5. Data Analysis

Descriptive statistics (mean, standard deviation) were calculated for all survey items. To examine the relationship between teacher technology adoption and student technology acceptance, Pearson correlation analysis was conducted.

8. DATA ANALYSIS

Table 1: Gender-wise Comparison of Teachers' Technology Adoption and Students' Technology Acceptance in Mathematics Education

Variable	Gender	N	Mean	SD	t	Remark
Teachers' Technology Adoption	Male	60	32.80	7.75	4.809	S
	Female	90	38.70	7.09		
Students' Technology Acceptance	Male	70	41.05	8.32	2.302	S
	Female	80	44.30	8.88		

Table 1 presents a gender-wise comparison of teachers' technology adoption and students' technology acceptance in mathematics education. For teachers, the results indicate a statistically significant difference in technology adoption between male and female teachers. Female teachers (M = 38.70, SD = 7.09) reported significantly higher levels of technology adoption compared to male teachers (M = 32.80, SD = 7.75), $t = 4.809$, $p < .01$. This suggests that female teachers are more inclined to integrate technology into their mathematics education than their male counterparts. Similarly, for students, a significant gender difference was found in technology acceptance. Female students (M = 44.30, SD = 8.88) demonstrated higher levels of technology acceptance than male students (M = 41.05, SD = 8.32), $t = 2.302$, *p* < .05. This indicates that female students are more receptive to the use of technology in mathematics education.

The findings reveal that female participants both teachers and students exhibited significantly higher levels of technology adoption and acceptance than male participants. These results may have important implications for policy makers, teacher educators, and curriculum designers seeking to foster equitable and effective technology integration in mathematics education. Efforts may be needed to further support and encourage male teachers and students in adopting and accepting technology-based approaches to teaching and learning mathematics.

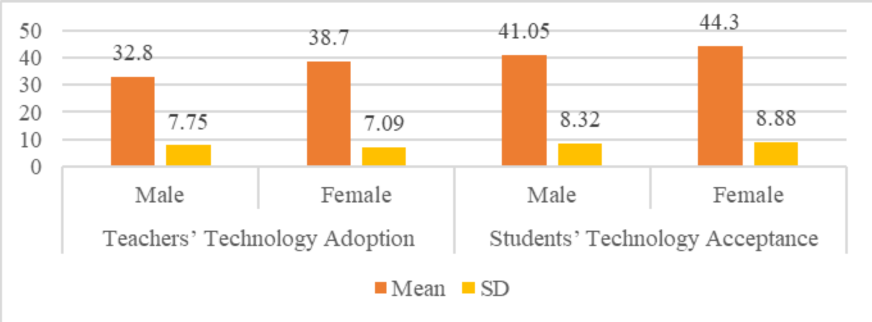

Figure1.1: Gender-wise Comparison of Teachers' Technology Adoption and Students' Technology Acceptance in Mathematics Education

Table 2: Locality-wise Comparison of Teachers' Technology Adoption and Students' Technology Acceptance in Mathematics Education

Variable	Locality	N	Mean	SD	t	Remark
Teachers' Technology Adoption	Rural	70	31.20	7.05	4.488	S
	Urban	80	37.10	8.80		
Students' Technology Acceptance	Rural	65	39.08	8.10	4.735	S
	Urban	85	45.90	9.20		

Table 2 presents a comparison of teachers' technology adoption and students' technology acceptance in mathematics education based on locality (rural vs. urban). For **teachers**, the findings indicate a significant difference in technology adoption between rural and urban areas. Urban teachers (M = 37.10, SD = 8.80) reported higher levels of technology adoption than their rural counterparts (M = 31.20, SD = 7.05), *t*= 4.488, *p* < .01. This suggests that urban teachers are more likely to integrate technology into their mathematics teaching practices, possibly due to better access to resources, infrastructure, or training opportunities. Similarly, among **students**, a significant difference was found in technology acceptance across localities. Urban students (M = 45.90, SD = 9.20) demonstrated significantly greater acceptance of technology in mathematics education than rural students (M = 39.08, SD = 8.10), *t* = 4.735, *p* < .01. This indicates that students in urban settings are more comfortable and receptive to the use of technology in learning mathematics.

These results highlight a **clear locality-based disparity** in both teachers' and students' engagement with technology. The findings underscore the need for targeted interventions in rural areas, including improved infrastructure, professional development for teachers, and increased access to digital tools for students. Addressing these gaps could help promote more equitable and effective technology integration in mathematics education across different regions.

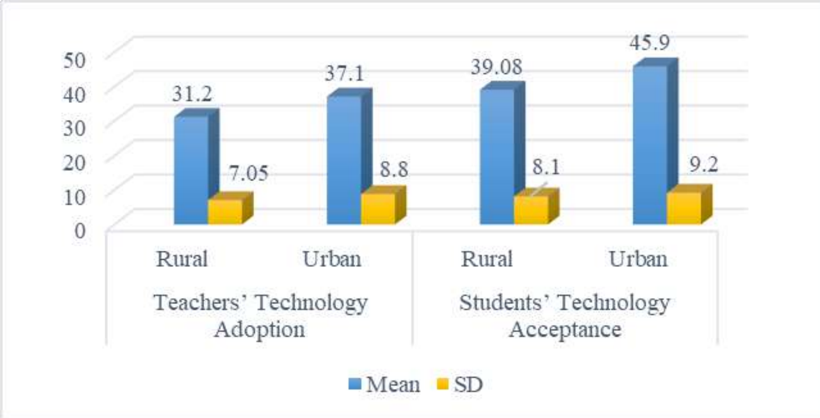

Figure1.2: Locality-wise Comparison of Teachers' Technology Adoption and Students' Technology Acceptance in Mathematics Education

Table 3: Type of school wise Comparison of Teachers' Technology Adoption and Students' Technology Acceptance in Mathematics Education

Variable	Type of School	N	Mean	SD	T	Remark
Teachers' Technology Adoption	Private	80	38.34	8.86	2.150	S
	Government	70	31.21	7.26		
Students' Technology Acceptance	Private	82	47.19	9.58	4.171	S
	Government	68	41.09	8.04		

Table 3 presents a comparison of teachers' technology adoption and students' technology acceptance in mathematics education based on the type of school (private vs. government). For teachers, a statistically significant difference was found in technology adoption between private and government schools. Teachers from private schools (M = 38.34, SD = 8.86) reported significantly higher levels of technology adoption than those from government schools (M = 31.21, SD = 7.26), $t = 2.150$, $p < .05$. This suggests that private school teachers may have greater access to technological resources, training opportunities, or institutional support for integrating technology into mathematics instruction. Similarly, a significant difference was observed in students' technology acceptance. Students from private schools (M = 47.19, SD = 9.58) demonstrated significantly higher acceptance of technology in mathematics education than students from government schools (M = 41.09, SD = 8.04), $t = 4.171$, $p < .01$. This indicates that private school students are generally more receptive to technology-enhanced learning environments.

Overall, the results highlight a notable disparity based on school type, with both teachers and students in private schools showing greater engagement with technology in mathematics education. These findings point to the need for enhanced investment in digital infrastructure, teacher training, and student support systems in government schools to bridge the gap and promote equitable access to technology-driven educational experiences.

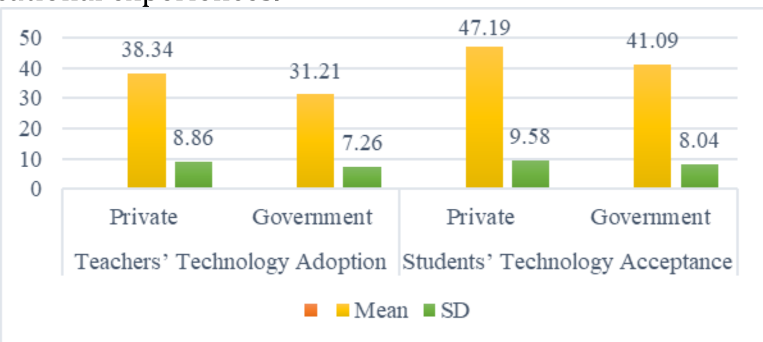

Figure1.3: Type of School Wise Comparison of Teachers' Technology Adoption and Students' Technology Acceptance in Mathematics Education

Table 4: Correlation between Teachers' Technology Adoption and Students' Technology Acceptance in Mathematics Education

Variable		Teachers' Technology Adoption	Students' Technology Acceptance
Teachers' Technology Adoption	Pearson Correlation	1	0.86 **
	Sig. (2-Tailed)		.000
	N	150	150
Students' Technology Acceptance	Pearson Correlation	0.86 **	1
	Sig. (2-Tailed)	.000	
	N	150	150

Note: **Correlation is significant at the 0.01 level (2-tailed).**

Table 4 shows the correlation between teachers' technology adoption and students' technology acceptance in mathematics education. A strong positive correlation was found between the two variables, $r = 0.86$, $p < .01$. This indicates that as teachers' adoption of technology increases, students' acceptance of technology in mathematics learning also increases significantly.

The strength of this relationship suggests that the way teachers integrate and model technology use in their classrooms may directly influence students' attitudes toward technology. These findings underscore the importance of supporting teachers in effectively adopting educational technologies, as their practices can have a meaningful impact on students' engagement and openness to technology-enhanced learning.

9. DISCUSSION FOR THE PRESENT STUDY

The present study examined the influence of gender, locality, and type of school on teachers' technology adoption and students' technology acceptance in mathematics education, as well as the correlation between these two constructs. The findings offer significant insights into how demographic and contextual factors shape technology integration in secondary mathematics classrooms.

The results revealed a statistically significant gender difference in both teachers' technology adoption and students' technology acceptance, with female teachers and students scoring higher than their male counterparts. This aligns with findings by **Inan and Lowther (2010)**, who reported that female educators were often more open to integrating new technologies when given proper support. Similarly, **Teo (2014)** found that female students were more receptive to technology-enhanced learning environments, potentially due to higher levels of digital literacy and collaborative engagement. However, these findings contrast with **Venkatesh and Morris (2000)**, who argued that male users tend to adopt new technologies more readily due to higher confidence in technical domains. This contradiction suggests that contextual variables such as subject area (mathematics) or school culture may play a moderating role.

Significant locality-based differences were also observed. Urban teachers and students demonstrated higher levels of technology adoption and acceptance than their rural counterparts. This supports previous research by **Tella et al. (2007)**, who attributed urban advantages to better access to digital infrastructure, internet connectivity, and institutional support. These disparities highlight the ongoing digital divide and reinforce the need for targeted policies to promote equitable technology integration across different geographic settings.

A comparison between government and private schools also showed significant differences. Teachers and students in private schools reported higher levels of technology use and acceptance than those in government schools. This is consistent with findings from **Ali,** Haolader, and Muhammad (2013), who noted that private institutions often have more flexible policies, better funding, and stronger ICT integration strategies. On the other hand, Agyei and Voogt (2011) suggested that even in resource-constrained government schools, teacher attitudes and leadership support could sometimes overcome structural limitations, indicating that school culture may be as important as infrastructure.

Most notably, a strong positive correlation (r = 0.86, p < .01) was found between teachers' technology adoption and students' technology acceptance. This result suggests that students are more likely to accept and engage with technology when their teachers actively use and model it in classroom instruction. This finding aligns with the Technology Acceptance Model (TAM) proposed by Davis (1989) and supports more recent evidence from Ertmer and Ottenbreit-Leftwich (2010), Sang et al. (2011), Lawless & Pellegrino (2007), Mouza (2008) Liu (2011) who emphasized the role of teacher practices in shaping students' perceptions of educational technology.

Overall, the study emphasizes the interconnectedness of teacher behavior and student attitudes in technology-rich environments. Addressing systemic inequalities, providing targeted professional development, and fostering a supportive school culture can further enhance both adoption and acceptance of technology in mathematics education.

The findings of this study offer several important implications for educators, school leaders, policymakers, and curriculum developers, particularly in the context of integrating technology into mathematics education.

10. EDUCATIONAL IMPLICATIONS

10.1. Teacher Training and Professional Development

The strong correlation between teachers' technology adoption and students' technology acceptance underscores the critical role of teachers in shaping students' attitudes toward educational technology. This highlights the need for regular, targeted professional development programs that enhance teachers' digital competence, especially in the effective use of ICT tools in mathematics instruction. Training should not only cover technical skills but also focus on pedagogical strategies that promote student engagement through technology.

10.2. Equity Across School Types and Localities

Significant differences observed between urban and rural schools, and between private and government schools, reveal ongoing disparities in access to and usage of technology. Educational stakeholders should prioritize resource allocation to under-resourced schools, ensuring equitable access to digital tools, internet connectivity, and technical support. Bridging this digital divide is essential to providing all students with equal learning opportunities.

10.3. Gender-Sensitive Technology Integration

The gender differences in technology adoption and acceptance suggest the importance of designing technology-based activities that are inclusive and sensitive to the preferences and learning styles of both male and female students. Encouraging female participation in digital and STEM-related activities can help foster greater gender balance in technology use and confidence.

10.4. Curriculum and Instructional Design

The findings support the integration of technology-enhanced learning environments into the mathematics curriculum. Educational planners should encourage the development of interactive digital content, math-specific software, and student-centered technology tools that support visualization, problem-solving, and critical thinking. This not only improves students' conceptual understanding but also increases their motivation and engagement in mathematics.

10.5. Policy and Leadership

At the policy level, ministries of education and school boards should adopt clear frameworks and guidelines that support the implementation of educational technology. School leadership should actively promote a technology-positive culture by modeling ICT use, setting clear expectations, and encouraging collaboration among teachers to share best practices.

11. CONCLUSION

The present study investigated the influence of gender, locality, and school type on teachers' technology adoption and students' technology acceptance in mathematics education,

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as well as the relationship between these two variables. The results revealed statistically significant differences based on gender, locality, and type of school, with female, urban, and private school participants demonstrating higher levels of technology adoption and acceptance. These findings highlight the persistent digital divide in educational settings, influenced by demographic and institutional factors.

Most notably, the study found a strong positive correlation (r = 0.86, p < .01) between teachers' technology adoption and students' technology acceptance. This underscores the critical role teachers play in shaping students' attitudes toward educational technologies. When teachers effectively integrate technology into mathematics instruction, students are more likely to perceive it as beneficial and engage with it more confidently.

These results support the need for ongoing teacher training, equitable resource distribution, and policy initiatives aimed at enhancing technology integration in all educational settings. By fostering a supportive digital environment and prioritizing teacher preparedness, schools can significantly improve students' engagement, understanding, and acceptance of technology in mathematics learning.

In conclusion, successful integration of technology in mathematics education is not only a matter of access but also of teacher readiness and institutional support. Enhancing these areas can lead to improved student outcomes and more equitable, technology-enhanced learning experiences.

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