The Application of TPACK Model in Teachers' Teaching Practices: A Study on Integration and Effectiveness

Mr. R. Vijayatheepan

University of Colombo, Sri Lanka

ABSTRACT

The integration of technology into teaching practices is critical for fostering 21st-century skills such as critical thinking, creativity, and digital literacy. This study investigates the application of the Technological Pedagogical Content Knowledge (TPACK) framework among Tamil-medium school teachers in the Jaffna Educational Division, Sri Lanka. The research focuses on three objectives: assessing teachers' self-reported knowledge and practices in technology integration, identifying challenges and barriers to its implementation, and examining the influence of TPACK components on classroom effectiveness. Data were collected from 142 teachers using structured questionnaires and classroom observations, analyzed through descriptive and inferential statistics. Findings revealed that while teachers displayed strong Pedagogical Knowledge (PK, mean = 4.2) and Content Knowledge (CK, mean = 4.1), their Technological Knowledge (TK, mean = 3.8) and integration skills (TPK = 3.9, TCK = 3.7) were moderate. Correlation analysis demonstrated significant positive relationships between TPACK components and teaching effectiveness, with Pedagogical Content Knowledge (PCK, r = 0.75) and Technological Pedagogical Knowledge (TPK, r = 0.73) showing the strongest correlations. Challenges identified included insufficient resources (58%), lack of training (42%), and limited preparation time (37%). Additional barriers unique to Tamil-medium schools included language constraints and cultural resistance to change. Classroom observations confirmed that teachers with higher TPACK competencies effectively engaged students through technology-enhanced practices, demonstrating improved lesson structure and student interaction. The study concludes that while teachers possess strong foundational teaching competencies, targeted professional development programs and localized digital resources are essential to enhance technology integration. Addressing infrastructure deficits and providing institutional support are crucial for overcoming barriers and ensuring equitable access to technology-enhanced education. These findings provide actionable insights for fostering effective technology integration in Tamil-medium schools, contributing to improved student outcomes in resource-constrained contexts.

Keywords: TPACK Model, Technology integration, Teaching Practices, Tamil Medium Schools

INTRODUCTION

In the digitalized world of the 21st century, many sectors have undergone significant transformations, becoming more innovative and efficient through the integration of technology. Education is no exception, as modern teaching and learning methods have rapidly evolved to incorporate technological advancements. Sri Lanka's educational history reflects numerous reforms designed to enhance learning and teaching practices. In July 2003, the Sri Lankan government underscored the importance of Information and Communication Technology (ICT) by establishing the Information and Communication Technology Agency (ICTA). While industries have developed comprehensive plans for ICT advancement, the integration of ICT into Sri Lanka's education system has progressed more gradually. The government's commitment to equipping the younger generation with advanced ICT knowledge is evident in the National Policy on Information Technology in School Education (NPITE), which aims to prepare students for the challenges of the 21st century (Educational

Development Board, 2021). This policy emphasizes not only integrating ICT into educational practices but also enhancing the management of the education system (Karunathilake & Vidanagama, 2021).

Despite improvements in school administration, research indicates limited progress in incorporating ICT into the teaching and learning processes of the certified curriculum. Teachers play a pivotal role in bridging this gap, as their technological, pedagogical, and content knowledge (TPACK) is essential for effective teaching (Mishra & Koehler, 2009). The effective integration of these knowledge domains can make teaching processes more productive and impactful.

The rapid advancements in technology have introduced new career aspirations, social expectations, and educational needs in the digital age. Students now seek learning experiences that extend beyond traditional knowledge acquisition, aiming to develop 21st-century skills such as critical thinking, creativity, collaboration, communication, and digital literacy (Harris et al., 2011). They desire educational opportunities that prepare them for a globally connected and evolving professional landscape. Frameworks like the TPACK model serve as vital guides for teachers navigating these demands, offering a structured approach to integrating technology with pedagogy and subject knowledge (Ghavifekr & Wan Athirah, 2015). The effective application of TPACK can transform traditional classrooms into dynamic and engaging learning environments.

In this context, by integrating technological proficiency, pedagogical strategies, and subject matter expertise, TPACK provides a systematic approach to technology integration in education. This study explores the strategies employed by teachers to utilize technology effectively in their classrooms, aiming to inform policy decisions and educational initiatives that can enhance teaching practices in Sri Lanka.

Significance of the study

This study holds significant academic, practical, and policy-level relevance, addressing critical gaps in the integration of technology within teaching practices in Sri Lanka. First, the research contributes to the academic discourse by examining the application of the Technological Pedagogical and Content Knowledge (TPACK) framework in the context of Tamil-medium schools in the Jaffna Educational Division. While the TPACK framework has been extensively studied in various global contexts, limited research exists on its implementation in Sri Lanka's unique educational landscape, which is characterized by resource constraints and exam-oriented teaching cultures. This study adds to the growing body of literature by offering insights into how teachers navigate these challenges and incorporate technology into their pedagogical practices.

Second, the study provides practical implications for educators by highlighting the current levels of technological, pedagogical, and content knowledge among teachers. By identifying key barriers such as limited access to technology, insufficient training, and workload pressures, the findings offer actionable recommendations to enhance teacher competencies and promote effective integration of ICT in classrooms. This is particularly crucial for fostering 21st-century skills among students, including critical thinking, creativity, and digital literacy, which are essential for success in an increasingly interconnected and technology-driven world.

Finally, the research has policy implications, as it informs educational stakeholders, including policymakers and school administrators, about the gaps and opportunities in technology integration. By addressing infrastructural disparities and prioritizing teacher professional development programs, educational authorities can create a more equitable and effective learning environment. The study's findings can guide the implementation of targeted interventions aligned with Sri Lanka's National Policy on Information Technology in School Education (NPITE), ultimately contributing to the country's broader goals of educational modernization and global competitiveness.

Hence, this study not only addresses the theoretical dimensions of TPACK but also provides practical strategies and policy-level recommendations to improve the integration of technology in teaching, thereby enhancing the overall quality of education in Sri Lanka.

Research objectives

- To analyze the current level of application of the Technological Pedagogical and Content Knowledge (TPACK) framework in teaching practices among Tamil-medium school teachers in the Jaffna Educational Division, Sri Lanka.
- To investigate the challenges and barriers that hinder the integration of technology into teaching practices in Tamil-medium schools.
- To assess the influence of teachers' technological, pedagogical, and content knowledge on the effectiveness of technology integration in the classroom.
- To propose actionable recommendations for enhancing technology integration in teaching, focusing on targeted professional development programs and optimized resource allocation

LITERATURE REVIEW

The integration of technology into teaching practices has become a cornerstone of contemporary education, particularly in the 21st century, where digital literacy and technological competency are essential for both educators and learners. The Technological Pedagogical and Content Knowledge (TPACK) framework, developed by Mishra and Koehler (2006), has emerged as a comprehensive model for understanding the knowledge domains teachers require to effectively integrate technology into their instruction. By combining technological, pedagogical, and content expertise, TPACK provides a structured approach to designing meaningful, technology-enhanced learning experiences. Studies highlight its significance in equipping teachers to meet diverse student needs in increasingly digital classrooms (Koehler et al., 2013).

In the context of Sri Lanka, the adoption of technology in education is an ongoing priority. The government has implemented various initiatives, such as the "Smart Classroom" project and the "e-Thaksalawa" digital learning platform, to promote ICT integration in schools (Ministry of Education Sri Lanka, 2020). However, effective integration often hinges on teachers' readiness and their ability to apply frameworks like TPACK in their instructional practices. Research suggests that while teachers recognize the importance of technology, they frequently encounter challenges such as inadequate training, limited access to resources, and a lack of institutional support (Perera & Wickramasinghe, 2021). These barriers are particularly pronounced in rural areas, including Tamil-medium schools in the Jaffna Educational Division.

Although the TPACK framework has been widely studied globally, limited research exists on its application within the Sri Lankan context, especially in Tamil-medium schools. Studies in similar contexts underscore the need to evaluate teachers' knowledge and competencies to identify gaps in technology integration (Chai et al., 2017). This highlights a critical need to understand how teachers in Jaffna utilize the framework and to identify factors influencing its effectiveness.

Theoretical Background

The Technological Pedagogical and Content Knowledge (TPACK) framework, introduced by Mishra and Koehler (2006), provides a holistic understanding of the knowledge teachers need to integrate technology effectively into their teaching practices. It emphasizes the interplay between three core knowledge domains: Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). These domains, when intersected, form critical combinations, Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK)—culminating in the TPACK model, which represents the dynamic knowledge required to design effective technology-enhanced instruction.

The TPACK framework underscores the idea that technology integration is not simply about mastering devices or software but about understanding how technology interacts with pedagogy and content to create meaningful learning experiences. For instance, a teacher proficient in TPACK can select appropriate technological tools

that align with the pedagogical strategies and the subject matter, ensuring that the technology complements rather than detracts from the learning process (Koehler & Mishra, 2009).

In practice, TPACK bridges the gap between theory and implementation. It acknowledges that teachers operate within complex environments where they must balance content-specific goals, diverse student needs, and rapidly evolving technologies. Studies suggest that successful TPACK implementation enhances student engagement, fosters critical thinking, and supports differentiated instruction (Chai et al., 2017). However, achieving proficiency in TPACK requires ongoing professional development, institutional support, and access to resources.
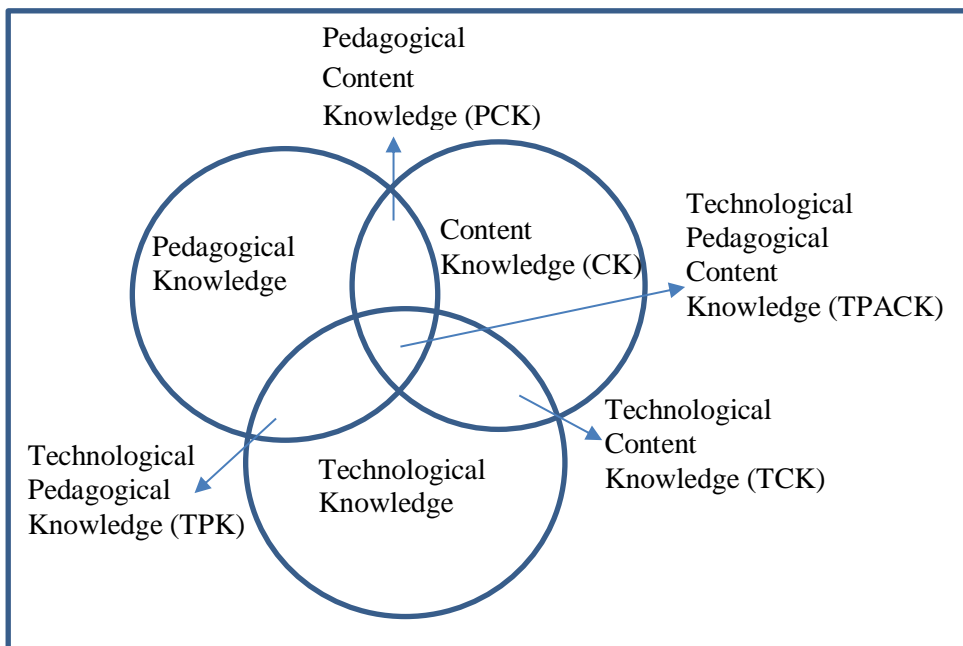

Figure 1 – TPACK Framework

Key Components of the TPACK Framework

1. Technological Knowledge (TK): Understanding the tools, software, and platforms that can be applied in teaching.
2. Pedagogical Knowledge (PK): Mastery of teaching methods, strategies, and techniques that facilitate learning.
3. Content Knowledge (CK): Deep understanding of the subject matter being taught.
4. TPACK Integration: The seamless integration of all three domains to create cohesive, technology-enhanced instructional strategies.

This theoretical foundation provides a lens through which this study investigates the readiness and application of TPACK among teachers in the Jaffna Educational Division.

Global Perspectives on TPACK Application

The Technological Pedagogical and Content Knowledge (TPACK) framework has been widely studied and implemented in various educational contexts around the world, showcasing its versatility and relevance in modern teaching practices. Globally, the integration of TPACK has demonstrated its potential to improve teaching efficacy and student learning outcomes, particularly in regions with robust ICT infrastructure and professional development programs.

In developed countries such as the United States, Australia, and Finland, the TPACK framework has been integrated into teacher education programs to prepare educators for technology-rich classrooms. For instance,

research in the U.S. has shown that TPACK-based training equips teachers with the skills to design innovative, technology-enhanced lessons that engage students and foster deeper understanding (Koehler et al., 2013). In Finland, a country renowned for its education system, teachers are encouraged to apply TPACK principles to blend traditional teaching methods with digital tools, creating adaptive learning environments that cater to diverse student needs (Sointu et al., 2020).

Emerging economies and developing nations have also begun to adopt the TPACK framework, albeit with varying levels of success due to contextual challenges. In countries like India, Indonesia, and South Africa, TPACK studies have highlighted the need for localized approaches to technology integration. For example, research in India indicates that while teachers are generally receptive to using technology, gaps in technological knowledge (TK) and limited access to resources often impede effective application (Rana et al., 2019). Similarly, in South Africa, socio-economic disparities have been identified as significant barriers to equitable TPACK implementation, underscoring the importance of tailored professional development and resource allocation (Nkula & Krauss, 2014).

In Asian contexts, the TPACK framework has gained traction as a means to address the rapid digital transformation in education. Studies in China and Singapore reveal that professional development programs emphasizing TPACK can significantly enhance teachers' confidence and competence in integrating technology (Chai et al., 2017). These programs often include collaborative learning opportunities, where teachers exchange best practices and develop contextually relevant solutions to classroom challenges.

While the TPACK framework offers a robust theoretical model, its global application also highlights common challenges. These include disparities in access to technology, resistance to change among educators, and the need for continuous training to keep pace with evolving digital tools. Despite these challenges, TPACK continues to serve as a vital framework for bridging the gap between traditional teaching practices and the demands of 21st-century education.

This global perspective provides valuable insights for understanding the potential of TPACK in Sri Lanka, particularly in the context of Tamil-medium schools in the Jaffna Educational Division. By learning from international experiences, this study aims to identify strategies for overcoming local challenges and enhancing the integration of technology in teaching practices.

Research Gaps

While the Technological Pedagogical and Content Knowledge (TPACK) framework has been extensively explored in global contexts, there is a notable lack of research examining its application in rural and resource-constrained educational settings, particularly in Sri Lanka. Most existing studies focus on developed countries with well-established ICT infrastructures, leaving a significant knowledge gap regarding the practical challenges and barriers faced by teachers in low-resource environments. Specifically, in the Jaffna Educational Division, where Tamil-medium schools operate amidst unique socio-economic and cultural conditions, the extent to which teachers understand and apply TPACK remains unclear.

Research in similar developing contexts has highlighted issues such as insufficient access to technology, lack of targeted professional development, and systemic challenges like inadequate funding and policy support (Rana et al., 2019; Nkula & Krauss, 2014). However, these studies do not address the nuanced needs of Tamil-medium schools in Sri Lanka, where linguistic and contextual factors play a critical role in shaping teaching practices. Furthermore, while previous research acknowledges the importance of teacher readiness for technology integration, there is limited empirical evidence on how gaps in technological, pedagogical, and content knowledge directly impact the effectiveness of teaching in these settings.

This study seeks to fill these gaps by providing a comprehensive analysis of TPACK application among Tamil-medium school teachers in the Jaffna Educational Division. It aims to identify the specific challenges they

face, evaluate the interplay of TPACK components in their teaching practices, and propose actionable recommendations to enhance technology integration. By addressing these research gaps, this study contributes to a deeper understanding of TPACK in under-researched contexts and offers practical solutions for improving education in Sri Lanka.

METHODOLOGY

This study employs a survey research design with mixed method approach, integrating both qualitative and quantitative data to provide a comprehensive understanding of the application of the TPACK framework among Tamil-medium school teachers. Data collection is conducted using a range of instruments, including questionnaires, and observations to gather primary data in the first phase. In the second phase, additional data is obtained through the analysis of teacher curriculum records and relevant documents to contextualize findings and validate insights.

Population and Sampling

The Jaffna Educational Division is one of the three divisions within the Jaffna Educational Zone, located in the Jaffna District of the Northern Province, Sri Lanka. This division consists of 24 schools that provide education to children in the area. These schools are categorized into three types: National schools, which are directly administered by the central government; Provincial schools, which are managed by the provincial councils; and Private schools, which are operated by private institutions and rely on fees paid by students.

This study focuses exclusively on provincial schools for several reasons. In the Sri Lankan school system, over 90% of schools are managed by provincial councils, making them representative of the majority. Furthermore, these schools face unique challenges, as many are situated in rural areas with students from economically disadvantaged backgrounds. Limited resources in these schools, particularly in rural areas, have been highlighted as significant barriers to effective education by previous research.

Table 1 below provides details on the number of teachers in the provincial schools within the Jaffna Educational Division, classified by school type.

Table 1: Distribution of Teachers in Provincial Schools by School Type

School Type	No of Schools	Male Teachers	Female Teachers
1 AB	1	10	32
1 C	6	47	142
Type 2	10	64	162

The Table 1 summarizes the distribution of teachers across provincial schools in the Jaffna Educational Division, categorized by school type. The division includes 1 AB schools, 1 C schools, and Type 2 schools, with a total of 17 schools included in the study. The highest number of teachers, both male and female, is found in Type 2 schools, while 1 AB schools have the lowest teacher count. This distribution highlights the variations in staffing across different school types within the division.

This study employs a stratified random sampling technique to ensure adequate representation of teachers across different school types in the Jaffna Educational Division. Stratification is based on the three school types: 1 AB, 1 C, and Type 2 schools. This approach allows for proportionate sampling from each stratum, maintaining the diversity and balance of the population.

From the total population of 473 teachers (121 male and 352 female), a sample of 30% was selected, resulting in 142 teachers being included in the study. The sample was proportionately distributed among the school types as follows:

Table 2: Proportionate Sampling Distribution of Teachers by School Type

School Type	No. of Schools	Male Teachers	Female Teachers
1 AB	1	6	10
1 C	10	47	64
Type 2	32	142	162

Data Collection Instruments

Questionnaire

The questionnaire was designed following the framework of earlier studies, such as those by Mishra and Koehler (2006) and Schmidt et al. (2009), who emphasized the importance of assessing each domain of the TPACK model to understand teachers' knowledge and practices effectively.

Table 3 Structure and Focus of the Questionnaire

Section	Focus	Details
Section 1	Demographic Information	Age, gender, teaching experience, qualifications, and access to technology in schools.
Section 2	Technological Knowledge (TK)	Teachers' confidence in using tools, software, and troubleshooting minor technical problems.
Section 3	Pedagogical Knowledge (PK)	Teaching strategies, classroom management, and assessment practices.
Section 4	Content Knowledge (CK)	Subject expertise, access to resources, and staying updated in the field.
Section 5	Technological Pedagogical Knowledge (TPK)	Frequency and effectiveness of integrating technology into teaching strategies.
Section 6	Technological Content Knowledge (TCK)	Use of technology to deliver subject-specific content.
Section 7	Pedagogical Content Knowledge (PCK)	Alignment of teaching strategies with content and interdisciplinary connections.
Section 8	Technological Pedagogical Content Knowledge (TPACK)	Teachers' ability to combine all domains effectively in teaching practices.
Section 9	Challenges and Barriers	Open-ended questions about resource availability, training needs, time constraints, and resistance to change.

Classroom Observation

In addition to the questionnaire, **classroom observation** was utilized as a complementary data collection tool to gain deeper insights into the practical application of the TPACK framework. Real-time observations were conducted during classroom sessions, focusing on how Tamil-medium school teachers integrated technology, pedagogy, and content knowledge in their instructional practices. A **structured observation checklist**, adapted from established TPACK frameworks (Mishra & Koehler, 2006; Harris et al., 2009), was employed to systematically document key aspects, ensuring consistency and reliability in data collection. The following table is described the checklist of classroom observation.

Table 4 Structure of Classroom Observation Checklist

Focus Area	Key Aspects Observed	Purpose
Use of Technological Tools	Integration of hardware (e.g., projectors, tablets) and software in instruction	Evaluate teachers' ability to incorporate technology into teaching practices effectively
Teaching Strategies	Methods employed to engage students (e.g., interactive lessons, group activities)	Assess the alignment of pedagogy with technology and content
Content Delivery	Clarity and structure of content presentation using technology	Determine how technology enhances subject-specific teaching
Classroom Engagement	Student participation and interaction during technology-enhanced lessons	Evaluate the impact of technology on student motivation and engagement

Document Analysis

As part of the data collection process, document analysis was employed to gather secondary data relevant to the application of the TPACK framework in teaching practices. This method involved the systematic review of existing documents such as lesson plans, instructional materials, school technology policies, and professional development program records.

Data Analysis

The data collected from the questionnaire, classroom observations, and document analysis were analyzed using both quantitative and qualitative approaches to address the research objectives comprehensively. Quantitative data from the questionnaire were analyzed using statistical methods, including descriptive statistics to summarize participants' demographic information and responses across the TPACK domains. Mean scores, standard deviations, and frequency distributions were calculated to assess teachers' self-reported levels of knowledge and practices in technology integration. Additionally, inferential statistical techniques such as correlation analysis were employed to explore relationships between teachers' TPACK components and their effectiveness in technology integration.

Qualitative data obtained from open-ended questionnaire responses, classroom observation notes, and document analysis were analyzed thematically. Thematic analysis was used to identify recurring patterns, insights, and barriers related to the application of the TPACK framework. For classroom observations, the data were coded to capture key aspects of teachers' instructional practices, including their choice of technological tools, adaptability of pedagogical methods, and engagement with content. Document analysis findings were integrated into the thematic framework to understand how institutional factors influenced teaching practices.

Ethical Considerations

Ethical approval is obtained prior to the study, ensuring compliance with research ethics. Participants are informed about the purpose of the study, their rights, and the confidentiality of their responses. Written consent is obtained from all participants, and anonymity is maintained throughout the research process.

This methodological framework ensures that the study captures both the breadth and depth of TPACK application in the Jaffna Educational division, providing actionable insights to inform future policy and practice.

RESULTS

Demographic Characteristics of Participants

The study included a sample of 142 teachers selected from provincial schools in the Jaffna Educational Division, representing three school types: 1 AB, 1 C, and Type 2 schools. The demographic characteristics of participants are given in Table 5.

Table 5 Demographic Characteristics of Participants

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	43	30.3
	Female	99	69.7
Age Group	20–29	17	12.0
	30–39	64	45.1
	40–49	46	32.4
	50+	15	10.5
Educational Qualification	Diploma in Education	20	14.1
	Bachelor's Degree	93	65.5
	Master's Degree	29	20.4
Teaching Experience (Years)	1–5	52	36.6
	6–10	42	29.6
	11–20	31	21.8
	21+	17	12.0
Access to Technology	Excellent	30	21.1
	Adequate	69	48.6
	Limited	43	30.3

Teachers' Knowledge of the Three Core Components of TPACK

To address the first research objective, the study examined teachers' self-reported levels of knowledge and practices in integrating technology into their teaching practices. The analysis focused on the six dimensions of the TPACK framework: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK). The findings, based on descriptive statistics, are summarized in Table 4.

Table 6 Descriptive Statistics of Teachers' Self-Reported Knowledge and Practices in Technology Integration

TPACK Dimension	Mean	Standard Deviation (SD)	Confidence Level (High/Very High)	Confidence Level (Moderate)	Confidence Level (Low)
Technological Knowledge (TK)	3.8	0.72	65%	30%	5%
Pedagogical Knowledge (PK)	4.2	0.65	78%	17%	5%
Content Knowledge (CK)	4.1	0.68	73%	25%	2%
Technological Pedagogical Knowledge (TPK)	3.9	0.70	62%	34%	4%

TPACK Dimension	Mean	Standard Deviation (SD)	Confidence Level (High/Very High)	Confidence Level (Moderate)	Confidence Level (Low)
Technological Content Knowledge (TCK)	3.7	0.74	58%	36%	6%
Pedagogical Content Knowledge (PCK)	4.0	0.66	70%	27%	3%

The table 6 summarizes teachers' self-reported levels of knowledge and practices in technology integration across six TPACK dimensions. The mean scores indicate that teachers exhibit high levels of Pedagogical Knowledge (PK) and Content Knowledge (CK), with mean values of 4.2 and 4.1, respectively. These results suggest that teachers are confident in their ability to teach effectively and maintain subject expertise.

However, slightly lower mean scores in Technological Knowledge (TK, 3.8), Technological Pedagogical Knowledge (TPK, 3.9), and Technological Content Knowledge (TCK, 3.7) reveal a need for targeted professional development in integrating technology with pedagogical and content strategies. Frequency distributions also highlight a moderate proportion of teachers reporting only "moderate" confidence in these dimensions, emphasizing areas for potential improvement.

Overall, while teachers demonstrate strong foundational knowledge in pedagogy and content, enhancing their technology integration skills, especially in TPK and TCK, could further support effective teaching practices.

Challenges and Barriers to Technology Integration in Tamil-Medium Schools

To address the second research objective, the study analyzed teachers' responses regarding the challenges and barriers hindering technology integration in Tamil-medium schools. Data were collected through structured questions in the questionnaire and open-ended responses, focusing on the key obstacles faced by teachers. The findings are summarized below:

Figure 2 Challenges and barriers to technology Integration
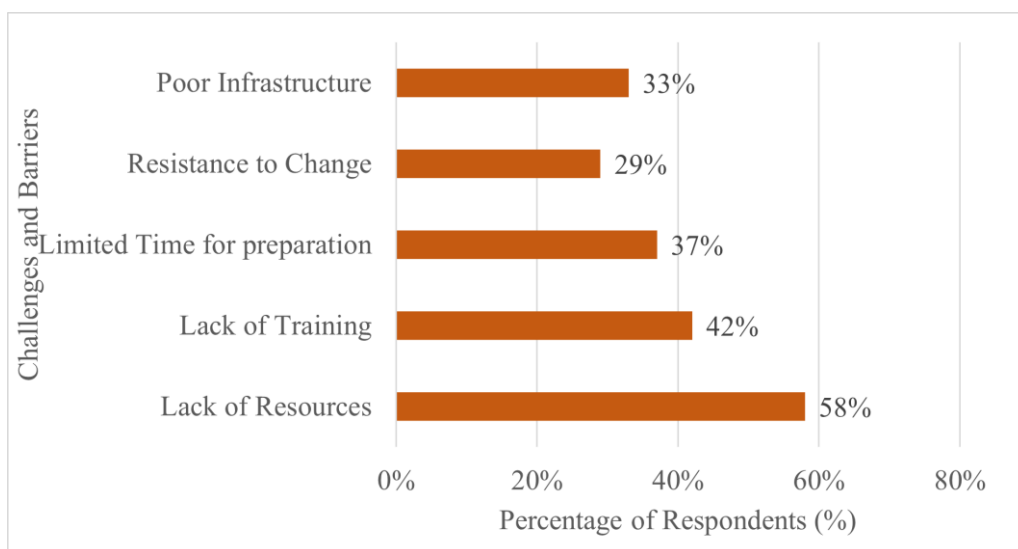
The horizontal bar chart highlights the key challenges faced by teachers in integrating technology into teaching practices. The most frequently reported barrier is the **lack of resources** (58%), followed by **insufficient training opportunities** (42%). **Limited time for preparation** (37%) and **poor infrastructure** (33%) also emerged as significant obstacles. Notably, **resistance to change** (29%) was the least reported barrier, though it still affects a substantial portion of respondents. These findings emphasize the need for enhanced resources, targeted professional development, and infrastructural improvements to support technology integration in Tamil-medium schools.

Thematic Analysis of Open-Ended Responses

Teachers' open-ended responses provided additional insights into challenges specific to Tamil-medium schools:

- Language Barriers: Many teachers noted that technology resources are often available only in English, making it difficult to use them effectively in Tamil-medium classrooms.
- Cultural Factors: Some teachers expressed concerns that integrating technology might conflict with traditional teaching norms and practices in Tamil-medium schools.
- Student Readiness: Teachers mentioned that a lack of digital literacy among students hinders the effective use of technology in classrooms.

Influence of Teachers' TPACK on the Effectiveness of Technology Integration

To address the third research objective, inferential statistical techniques, specifically correlation analysis, were conducted to examine the relationship between teachers' TPACK components and their effectiveness in integrating technology into classroom practices. The analysis utilized data from the questionnaire and classroom observations, focusing on the six core dimensions of TPACK.

Correlation Analysis Results

The correlation analysis revealed significant positive relationships between TPACK components and the effectiveness of technology integration, as summarized in Table 7.

Table 7 Correlation Between TPACK Components and Effectiveness in Technology Integration

TPACK Component	Correlation Coefficient (r)	Significance Level (p)	Interpretation
Technological Knowledge (TK)	0.58	< 0.01	Moderate positive relationship
Pedagogical Knowledge (PK)	0.67	< 0.01	Strong positive relationship
Content Knowledge (CK)	0.62	< 0.01	Strong positive relationship
Technological Pedagogical Knowledge (TPK)	0.73	< 0.01	Strong positive relationship
Technological Content Knowledge (TCK)	0.70	< 0.01	Strong positive relationship
Pedagogical Content Knowledge (PCK)	0.75	< 0.01	Strong positive relationship

Classroom Observation Findings

Classroom observations supported the statistical findings, illustrating that teachers with higher scores in TPACK components demonstrated:

- Effective use of technology to enhance student engagement and comprehension.
- Well-structured lesson plans that integrated technology seamlessly with pedagogy and content.
- Improved student interaction, especially in activities utilizing digital tools.

The results indicate that all TPACK components significantly influence the effectiveness of technology integration in classrooms, with the strongest correlations observed for PCK ($r = 0.75$) and TPK ($r = 0.73$). These findings suggest that teachers' ability to integrate technology effectively is most enhanced when they possess a balanced combination of pedagogical, content, and technological knowledge.

DISCUSSION

This section discusses the findings of the study in relation to each research objective, linking them to relevant literature to provide deeper insights into the results.

Teachers' Self-Reported Knowledge and Practices in Technology Integration

The study found that teachers exhibited strong Pedagogical Knowledge (PK) and Content Knowledge (CK), with mean scores of 4.2 and 4.1, respectively. However, their Technological Knowledge (TK) and abilities to integrate technology with pedagogy and content (TPK and TCK) were relatively lower, reflecting moderate confidence in these areas.

These findings align with Schmidt et al. (2009), who highlighted the inherent challenges of achieving balance within the TPACK framework. Similarly, Chai et al. (2013) noted that while teachers often excel in pedagogy and content knowledge, technological integration remains a weaker area due to limited exposure and training opportunities. Furthermore, Niess (2005) emphasized that integrating technology into teaching practices requires both technical proficiency and a conceptual understanding of how technology supports pedagogy and content, an area where gaps were evident in this study.

Challenges and Barriers to Technology Integration in Tamil-Medium Schools

The study identified key barriers to technology integration, including insufficient resources (58%), lack of training (42%), and limited preparation time (37%). Additionally, language barriers and cultural factors unique to Tamil-medium schools emerged as critical challenges.

Consistent with this study, Ertmer (1999) categorized barriers to technology integration into "first-order barriers" (e.g., resources and infrastructure) and "second-order barriers" (e.g., teacher attitudes and beliefs). The prevalence of first-order barriers in Tamil-medium schools aligns with findings from Pelgrum (2001), who noted that inadequate resources, particularly in rural and underprivileged areas, are a global issue. Similarly, Holmes et al. (2013) found that time constraints significantly hinder teachers' ability to plan and execute technology-integrated lessons.

Influence of Teachers' TPACK on Technology Integration Effectiveness

The correlation analysis revealed that all TPACK components positively influenced teachers' effectiveness in technology integration, with the strongest relationships observed for Pedagogical Content Knowledge (PCK, $r = 0.75$) and Technological Pedagogical Knowledge (TPK, $r = 0.73$). Classroom observations supported these findings, showing that teachers with higher TPACK competencies demonstrated better student engagement and lesson quality.

This is consistent with Abbitt (2011), who found that PCK and TPK are critical for effective technology integration, as they enable teachers to tailor their teaching strategies to the digital tools available. Similarly, Harris and Hofer (2011) highlighted that the ability to blend pedagogy, content, and technology is essential for creating meaningful learning experiences. Additionally, Mishra and Koehler (2006) emphasized that a well-developed TPACK framework empowers teachers to overcome contextual challenges and use technology creatively in their classrooms.

CONCLUSION

This study investigated the nature of teachers in Tamil-medium schools within the Jaffna Educational Division to integrate technology into their teaching practices, focusing on their TPACK (Technological Pedagogical Content Knowledge) competencies, the challenges they face, and the factors influencing the effectiveness of technology integration.

The findings revealed that while teachers exhibit strong Pedagogical Knowledge (PK) and Content Knowledge (CK), their Technological Knowledge (TK) and the ability to integrate technology with pedagogy and content (TPK and TCK) are relatively weaker. This indicates a need for targeted training programs to enhance their technological integration skills.

The study also identified significant barriers to technology integration, including insufficient resources, lack of training, limited preparation time, and infrastructural deficits, with unique challenges such as language barriers in Tamil-medium schools. These challenges align with global findings but are compounded by the cultural and contextual factors specific to the region.

Moreover, the correlation analysis demonstrated that all TPACK components positively influence the effectiveness of technology integration, with Pedagogical Content Knowledge (PCK) and Technological Pedagogical Knowledge (TPK) showing the strongest relationships. This underscores the importance of a balanced and well-developed TPACK framework in enabling effective teaching practices.

In conclusion, while Tamil-medium teachers possess foundational teaching competencies, addressing their technological skills and the contextual barriers they face is crucial. Strengthening TPACK competencies through professional development, coupled with infrastructural and resource improvements, can significantly enhance technology integration and improve educational outcomes in Tamil-medium schools.

Suggestions

Based on the findings and conclusions of this study, the following suggestions are proposed to enhance technology integration in Tamil-medium schools within the Jaffna Educational Division:

1. **Professional Development Programs:**

   o Design and implement targeted training programs to strengthen teachers' Technological Knowledge (TK) and their ability to integrate it effectively with pedagogy and content (TPK and TCK).
   o Provide ongoing workshops and hands-on training sessions to enhance teachers' confidence and competence in using technology for teaching.

2. **Localized Technology Resources:**

   o Develop and distribute digital teaching resources in the Tamil language to address language barriers and make technology more accessible for teachers and students.
   o Collaborate with educational software developers to create culturally relevant content tailored to the needs of Tamil-medium schools.

3. **Infrastructure Improvement:**

   o Ensure schools are equipped with adequate technological infrastructure, including computers, projectors, multimedia tools, and stable internet connectivity.
   o Address power supply issues in rural schools to facilitate uninterrupted use of technology in classrooms.

4. **Administrative and Policy Support:**

   o Encourage educational administrators to allocate sufficient time for teachers to plan and implement technology-based lessons.
   o Establish support systems, such as technical assistance teams, to help teachers troubleshoot and integrate technology effectively.

5. **Fostering a Positive Attitude Toward Technology Integration:**

   o Promote awareness programs to overcome resistance to change among teachers, emphasizing the benefits of technology-enhanced teaching for student engagement and learning outcomes.
   o Highlight success stories of effective technology integration to motivate teachers and encourage adoption.

6. **Student Readiness and Digital Literacy:**

   o Implement programs to improve students' digital literacy, ensuring they can actively engage with technology-based teaching methods.
   o Provide opportunities for students to access and utilize digital tools both in and outside the classroom.

7. **Future Research Directions:**

   o Conduct further studies to evaluate the long-term impact of professional development programs on teachers' TPACK competencies.
   o Investigate the effectiveness of specific localized digital tools and strategies in addressing the unique challenges faced by Tamil-medium schools.

By addressing these areas, Tamil-medium schools in the Jaffna Educational Division can overcome existing challenges and barriers, paving the way for more effective technology integration and enhanced educational outcomes.

REFERENCES

1. Abbitt, J. T. (2011). Measuring technological pedagogical content knowledge in preservice teacher education. Journal of Research on Technology in Education, 43(4), 281–300.
2. Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2013). A review of the quantitative measures of technological pedagogical content knowledge (TPACK). The Asia-Pacific Education Researcher, 22(4), 535–546.
3. Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. Educational Technology Research and Development, 47(4), 47–61.
4. Ghavifekr, S., & Wan Athirah, W. R. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. International Journal of Research in Education and Science, 1(2), 175–191.
5. Harris, J., Mishra, P., & Koehler, M. J. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. Journal of Research on Technology in Education, 41(4), 393–416.
6. Holmes, K., Preston, G., Shaw, K., & Buchanan, R. (2013). 'Follow' me: Networked professional learning for teachers. Australian Journal of Teacher Education, 38(12), 89–103.
7. Karunathilake, A., & Vidanagama, D. (2021). An evaluation of ICT integration in Sri Lanka's school education system. Educational Development Board, 17(3), 45–59.
8. Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? Contemporary Issues in Technology and Teacher Education, 9(1), 60–70.
9. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054.
10. Nkula, K., & Krauss, K. E. (2014). The integration of ICTs in marginalized schools in South Africa: Considerations for understanding the perceptions of in-service teachers and the role of training. International Journal of Education and Development Using ICT, 10(3), 36–52.
11. Pelgrum, W. J. (2001). Obstacles to the integration of ICT in education: Results from a worldwide educational assessment. Computers & Education, 37(2), 163–178.
12. Perera, H. N., & Wickramasinghe, I. (2021). Examining the challenges of integrating ICT in rural schools: A Sri Lankan perspective. Journal of Educational Technology, 18(3), 123–134.

13. Rana, N., Dwivedi, Y. K., & Williams, M. D. (2019). Educational technology adoption in rural schools: Identifying barriers and enablers. Education and Information Technologies, 24(2), 123–145.

14. Sointu, E., Valtonen, T., Kukkonen, J., & Väisänen, P. (2020). Examining the pedagogical use of technology in Finnish classrooms. Education and Information Technologies, 25(1), 295–307.

15. Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge: A review of the literature. Journal of Computer Assisted Learning, 29(2), 109–121.

16. Watson, J. (2006). Barriers to the integration of ICT in teaching and learning: A practitioner's perspective. Education and Information Technologies, 11(3-4), 191–206.