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# Enhancing Information Literacy of Primary School Teachers in Smart Education Environments

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**Abstract**

**Background and Aim:** Smart education environments require primary school teachers to possess high levels of information literacy—the ability to effectively access, evaluate, and use digital information. This study aims to explore strategies for enhancing information literacy among primary school teachers in rapidly evolving technological teaching contexts.

**Materials and Methods:** A mixed-methods approach was employed, combining quantitative surveys (n=100) across diverse regions with qualitative in-depth interviews (n=30). Surveys were analyzed using statistical methods (SPSS), while interview data underwent thematic coding analysis to ensure triangulation and provide a comprehensive understanding of the phenomenon.

**Results:** Findings revealed that 65% of primary school teachers demonstrated insufficient critical information evaluation skills despite basic technological proficiency. Key factors influencing information literacy included frequency of technology use ($r=0.67$, $p<0.01$), participation in targeted professional development programs, and institutional technological infrastructure. Rural teachers faced significantly greater challenges with technological access ($p<0.05$).

**Conclusion:** Enhancing primary school teachers' information literacy requires a systematic approach including: (1) context-specific professional development focusing on critical evaluation skills; (2) improved technological infrastructure; (3) collaborative learning communities; and (4) policy changes addressing digital divides between urban and rural educational settings. These strategies are essential for improving teaching quality and supporting sustainable smart education implementation.

**Keywords**: Information Literacy; Primary School Teachers; Smart Education; Educational Technology; Teacher Training; Mixed-Methods

## Introduction

In the 21st century, the rapid advancement of information and communication technologies (ICT) has significantly reshaped various sectors of society, with education being among the most impacted (UNESCO, 2021). Among the key technological innovations, smart education has emerged as a transformative force in how education is delivered and experienced. Smart education environments utilize interactive technologies, cloud computing, and big data analytics to create dynamic and personalized learning experiences (Zhu et al., 2021). This integration of technology has the potential to enhance the quality and accessibility of education worldwide. However, to fully harness the potential of these technologies, it is crucial that educators, especially primary school teachers, possess strong information literacy skills.

Information literacy is defined as the ability to access, evaluate, and use information effectively across various formats (American Library Association [ALA], 2000). This competency goes beyond technical skills and includes the critical ability to recognize when information is needed, to locate it effectively, to assess its quality and relevance, and to use it appropriately for problem-solving and informed decision-making (Association of College & Research Libraries [ACRL], 2016). Within a smart education framework, teachers' information literacy is vital for integrating digital resources into teaching practices and supporting students' learning outcomes (Bruce, 2020).

Despite growing recognition of the importance of information literacy, research on enhancing this competency among primary school teachers in the context of smart education remains limited (OECD, 2022). While much of the literature focuses on higher education, the unique challenges faced by primary school teachers in developing their information literacy skills have not been adequately addressed (Zhang



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& Liu, 2021). Primary school teachers are foundational in shaping young learners' cognitive development, and their ability to use digital tools effectively can significantly influence the quality of teaching and the overall learning experience of students (Mishra & Koehler, 2006). As digital technologies become increasingly integrated into educational settings, it is essential that primary school teachers not only possess subject-specific knowledge but also the ability to integrate technology in a pedagogically sound manner. Therefore, improving teachers' information literacy is crucial for advancing the quality of education and preparing students for success in an increasingly digital world (Mishra & Koehler, 2006).

This study aims to address the gap in the literature by investigating the current state of information literacy among primary school teachers, identifying the factors that influence its development, and proposing strategies to enhance teachers' information literacy within the framework of smart education. Specifically, the study will focus on the following research questions:

What is the current level of information literacy among primary school teachers in smart education environments?

What factors influence the development of information literacy among primary school teachers?

What strategies can effectively enhance information literacy among primary school teachers?

This research will contribute to the understanding of how primary school teachers can better integrate digital resources into their teaching practices, ultimately helping students develop the skills necessary to navigate the digital age effectively.

## Objectives

This study aims to address the identified gap in research concerning the development of information literacy among primary school teachers in smart education environments. The research is guided by the following specific objectives:

Objective 1: To assess primary school teachers' information literacy competencies across five key dimensions: information access, evaluation, integration, creation, and ethical use. This will involve identifying specific strengths and deficiencies in each area within various smart education environments.

Objective 2: To analyze the relative influence of personal, institutional, and technological factors on teachers' information literacy development. Personal factors include digital self-efficacy, prior technology experience, and attitudes toward technology; institutional factors involve professional development opportunities, leadership support, and technology policies; and technological factors concern the accessibility, reliability, and usability of digital tools.

Objective 3: To propose and validate evidence-based strategies for enhancing teachers' information literacy. These strategies will address the competency gaps identified and consider varying resource levels across different educational contexts.

## Literature review

### Introduction to Information Literacy in Education

The integration of digital technologies into education has drastically reshaped the interaction between teachers, students, and information. The concept of "smart education," which utilizes digital tools, cloud computing, and big data analytics in educational settings, has emerged as a key innovation in modernizing learning environments (Zhu et al., 2022). This shift has significantly heightened the demand for teachers to develop robust information literacy skills. Information literacy, as defined by the ACRL (2016), is the ability to recognize when information is needed, locate it efficiently, evaluate its credibility, and use it ethically to solve problems and make informed decisions. In the context of today's educational systems, this competency has become essential, as teachers not only need to acquire knowledge themselves but must also guide their students in developing these critical skills (UNESCO, 2022).

Given the increased digitalization of educational environments, information literacy has become indispensable for teachers to effectively integrate technology into their pedagogical practices (Lloyd & Talja, 2019). Recent studies underscore the significance of empowering teachers with the competencies



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required to navigate and critically assess information across various digital formats (Becker et al., 2023). The importance of these skills is further amplified as schools increasingly adopt digital resources, making it crucial for teachers to help students evaluate and apply knowledge effectively within a digitally-driven society (Gunter, 2021).

**Theoretical Frameworks of Information Literacy in Education**

Several theoretical frameworks have been developed to guide the understanding of information literacy within educational settings. The ACRL Framework for Information Literacy (2016) has been widely adopted as a foundational model for defining and enhancing information literacy competencies in higher education, and it provides a useful reference for understanding the broader concept of information literacy. Similarly, UNESCO's Media and Information Literacy (MIL) Framework offers a comprehensive view of how individuals can engage with digital information in responsible and ethical ways (UNESCO, 2020). These frameworks highlight the key dimensions of information literacy, including access, evaluation, creation, and ethical use of information, all of which are crucial in the context of smart education environments.

In the primary education context, the TPACK (Technological Pedagogical Content Knowledge) framework is particularly relevant. It emphasizes the intersection of content knowledge, pedagogical strategies, and technological tools to effectively teach students. TPACK has been shown to enhance teachers' ability to integrate technology into their practice, making it a critical framework for understanding how primary school teachers can improve their information literacy skills (Mishra & Koehler, 2006; Voogt et al., 2022).

**Empirical Studies on Primary Teachers' Digital Competencies**

Recent empirical research highlights the growing need for primary school teachers to develop strong digital competencies. For instance, a study by Gupta et al. (2023) found that teachers' digital skills are directly correlated with their ability to incorporate technology into classroom teaching, which in turn enhances student engagement and learning outcomes. Despite the importance of these competencies, many teachers still struggle with integrating digital tools due to a lack of training and support (Zhang & Liu, 2022).

In a study focusing on primary education, Wilson et al. (2023) found that many primary school teachers, especially in rural areas, face significant barriers to accessing the necessary technology and professional development resources. These barriers contribute to disparities in teachers' ability to leverage digital tools effectively in their teaching. Similarly, Chen (2021) reported that primary school teachers often lack the critical thinking skills necessary to evaluate and integrate digital content into their lessons, a gap that can be mitigated through targeted professional development and increased access to resources.

**Pedagogical Approaches to Developing Teacher Information Literacy**

Pedagogical approaches to developing teacher information literacy emphasize the integration of critical thinking, problem-solving, and technology skills into teacher education programs. Professional development initiatives focused on digital literacy are essential for fostering these competencies. According to Wilson and Sutherland (2022), teachers who engage in ongoing professional development programs focused on digital literacy report greater confidence in using technology to enhance teaching. Moreover, these programs enable teachers to stay updated with the latest technological tools and methodologies, making it possible for them to adapt to the rapidly changing digital landscape of education.

Another critical pedagogical approach is collaborative learning. Research by Huang et al. (2021) suggests that teachers who engage in peer learning and collaborative communities are more likely to overcome challenges related to technology integration. This approach not only improves digital competencies but also fosters a culture of lifelong learning, which is vital for keeping pace with technological advancements in education.

**Assessment of Information Literacy in Educational Contexts**

Assessing teachers' information literacy remains a challenging task, as it involves measuring a wide range of competencies that span technical skills, critical thinking, and ethical considerations. Recent studies



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have developed frameworks for assessing teachers' digital competencies, such as the DigCompEdu framework, which focuses on the integration of digital technologies into teaching practice (European Commission, 2020). This framework highlights the need for teachers to possess both technical skills and pedagogical knowledge to effectively use digital tools in their teaching.

In the context of primary education, it is essential to develop assessment tools that specifically address the developmental stages of both teachers and students. Gunter (2021) argues that while secondary and higher education often focus on digital literacy in content-heavy contexts, primary school education requires a unique approach that considers the cognitive development of younger students and the specific needs of their teachers in navigating technology. The assessment should thus be tailored to the realities of primary education, incorporating both subjective and objective measures of teachers' digital literacy.

**Challenges in Enhancing Information Literacy Among Primary School Teachers**

Despite the recognized importance of information literacy, primary school teachers face numerous challenges in enhancing their digital competencies. One major challenge is the lack of sufficient professional development opportunities that are aligned with the demands of digital education (Becker et al., 2023). Additionally, many teachers face challenges related to the availability and accessibility of technological resources, particularly in underfunded or rural schools. Wu and Lin (2021) highlight how disparities in access to technology exacerbate these challenges, creating a digital divide that hinders teachers' ability to improve their information literacy.

Furthermore, there is a lack of tailored digital literacy programs for primary school teachers that address the unique needs of this educational level. The developmental needs of young students require teachers to adopt different strategies for integrating technology, which is not always reflected in the professional development programs available to them (Zhu et al., 2022). This gap in teacher training presents a significant barrier to the effective integration of digital tools in primary education.

Conclusion

The increasing reliance on digital technologies in education presents significant opportunities for enhancing teaching and learning, yet numerous challenges exist in developing information literacy among primary school teachers. These challenges include insufficient professional development opportunities, disparities in technological access, and the lack of tailored training programs for primary education contexts. Addressing these barriers is crucial to ensuring that all teachers have the competencies and resources they need to successfully integrate digital tools into their teaching practices, ultimately improving educational outcomes for students.

## Conceptual Framework

The conceptual framework for this study is based on the intersection of information literacy, teacher competencies, and the implementation of smart education. The framework explores how these elements are interrelated and how they collectively influence the ability of primary school teachers to integrate technology into their pedagogical practices effectively. The framework is designed to provide a comprehensive understanding of how various individual, institutional, and technological factors impact the development of teachers' information literacy in the context of smart education.

**Information Literacy**

In this context, information literacy refers to a set of skills and attitudes that enable educators to efficiently access, evaluate, and use information through digital tools and platforms. These competencies are critical for teachers to navigate the digital landscape, and they directly affect their pedagogical effectiveness, particularly in environments where the integration of technology is crucial. Information literacy encompasses several components, including:

Information Access: The ability to identify and locate the necessary digital resources.

Information Evaluation: The ability to critically assess the quality and relevance of digital information.



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Information Integration: The ability to combine various digital resources into teaching and learning activities.

Ethical Use: The ability to use information responsibly, understanding issues related to copyright and ethical guidelines.

The development of these competencies is central to a teacher's ability to successfully engage with smart education technologies.

**Teacher Competencies and Smart Education**

Teacher competencies in this framework are closely linked to a teacher's ability to integrate and utilize digital tools in a meaningful way. Competencies in this context include the technological pedagogical content knowledge (TPACK) framework, which emphasizes the integration of technology with content and pedagogical strategies (Mishra & Koehler, 2006). According to this framework, effective teaching in a smart education environment is not only about possessing technical skills but also understanding the educational potential and limitations of digital technologies.

Smart education is characterized by the use of digital tools, interactive learning platforms, and data-driven instructional methods. It transforms traditional educational models by creating personalized, dynamic learning experiences (Zhu et al., 2022). The success of these technologies largely depends on teachers' ability to integrate them into their practices. Teachers need to have a comprehensive understanding of these technologies, beyond just technical proficiency, to use them effectively for enhancing student learning (Becker et al., 2023).

**Key Influencing Factors**

The framework highlights several key factors that influence the development of information literacy among teachers:

Individual Factors: These include prior experience with technology, digital self-efficacy (the belief in one's ability to use technology), and motivation to embrace digital tools. These factors shape how a teacher interacts with technology and how willing they are to engage in developing their information literacy.

Institutional Support: This includes professional development opportunities, access to training, and leadership support. Institutional factors play a critical role in providing teachers with the resources and training necessary to enhance their digital competencies. Professional development programs aligned with teachers' needs, especially regarding digital literacy, are essential for fostering these skills (Wilson et al., 2023).

Technological Infrastructure: Access to technological tools, reliable internet connectivity, and educational resources are fundamental to the successful integration of smart education. Schools with strong technological infrastructure provide teachers with the tools needed to effectively incorporate technology into their teaching practices (Wu & Lin, 2021).

**Theoretical Grounding**

This framework builds upon established models such as the ACRL Framework for Information Literacy (2016) and TPACK (Mishra & Koehler, 2006). The ACRL framework provides a foundational understanding of information literacy, particularly in its ability to guide educators in navigating the digital world. The TPACK framework is particularly relevant in this study as it links the integration of technology to teaching practice, illustrating how teachers' competencies must extend beyond technical skills to include pedagogical strategies that leverage digital tools effectively.

Relationships Between Components

The framework assumes that teacher competencies in digital literacy are crucial for successfully implementing smart education. Teachers' information literacy competencies are not isolated; they are influenced by individual factors such as experience, institutional support like training programs, and the availability of technological resources. The interrelationships between these components form a complex, dynamic system that shapes the development of teachers' ability to use digital tools for effective teaching.



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This study posits that information literacy development among teachers is a continuous process influenced by personal attributes, institutional contexts, and technological environments. Each factor interacts with others, creating opportunities and challenges for enhancing digital literacy in primary education settings.

Innovation and Contribution

This conceptual framework extends existing models by focusing specifically on primary education, an area that has received less attention in information literacy research compared to secondary or higher education. By considering the developmental needs of primary school teachers and the unique demands of younger students, this framework provides novel insights into how information literacy and technology integration are critical at the primary education level.

Connection to Research Objectives

This framework directly informs the study's research objectives. It provides the foundation for assessing the current state of information literacy among primary school teachers, identifying key factors that influence its development, and proposing effective strategies for enhancement. The framework guides the methodological approach, specifically in terms of identifying which individual, institutional, and technological factors should be examined and how they interact to shape teachers' digital competencies.

Conclusion, in summary, this conceptual framework illustrates the relationships between information literacy, teacher competencies, and smart education, with a focus on how individual, institutional, and technological factors influence teachers' development of information literacy. It also provides a structured approach for investigating these dynamics in primary education contexts, offering a deeper understanding of the challenges and opportunities teachers face in integrating digital tools into their teaching practices.

## Methodology

This study employs a mixed-methods approach to assess the current state of information literacy among primary school teachers in smart education environments, explore the factors influencing its development, and propose strategies for its enhancement. This approach combines both quantitative and qualitative data collection techniques, which allow for a comprehensive understanding of the issues at hand and provide both breadth and depth to the findings. The use of a mixed-methods approach enhances the study by enabling the triangulation of data, providing a richer understanding of the challenges teachers face in developing their information literacy and how these challenges can be addressed.

### Research Design

The research design follows a sequential explanatory strategy (Creswell & Plano Clark, 2017), where quantitative data is collected and analyzed first, followed by qualitative data collection to further explore and explain the quantitative findings. This design is ideal for exploring the relationship between teachers' digital competencies and the various factors influencing their information literacy in primary education contexts.

### Sampling Strategy

A stratified purposive sampling method was employed to select participants for both the survey and interviews. The study aimed to include a representative sample of primary school teachers from a range of educational settings, including urban, suburban, and rural schools. The stratification was based on school location and teacher experience to ensure diversity across these variables.

Quantitative Sampling: A total of 150 primary school teachers were selected to complete the survey. These teachers were chosen to represent different educational settings (urban, suburban, rural) and varied levels of teaching experience (from 1 to 30 years). This sampling method allows for a more comprehensive understanding of the factors influencing information literacy across different contexts.

Qualitative Sampling: A subset of 30 teachers who participated in the survey was selected for the qualitative interviews. These teachers were chosen using maximum variation sampling, ensuring that participants represented a range of experience levels, geographical locations, and digital competencies. This approach was designed to capture diverse perspectives and provide a rich understanding of the teachers' experiences with digital technologies.



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**Instrument Development**

The instruments for data collection include a structured survey and a semi-structured interview protocol.

Survey Development: The survey was designed to assess teachers' self-reported levels of information literacy, including their ability to use digital tools, evaluate digital resources, and incorporate technology into their teaching practices. The survey was adapted from established instruments, such as the DigCompEdu framework (European Commission, 2020) and the ACRL Framework for Information Literacy (2016), with modifications to suit the primary school context.

The survey included questions on:

Teachers' technological proficiency.

Frequency of technology use in the classroom.

The ability to integrate digital tools to enhance student learning outcomes.

The level of access to technological resources, such as internet connectivity, digital devices, and educational software.

Content validity was established through expert review, and the reliability of the survey was tested using Cronbach's alpha, which yielded a value of 0.87, indicating good internal consistency.

Interview Protocol Development: The semi-structured interview protocol was developed to explore teachers' experiences and challenges in enhancing their information literacy. The questions were aligned with the research objectives and aimed to provide deeper insights into the factors that influence teachers' ability to integrate technology into their teaching practices. Topics included:

Barriers to improving digital competencies.

Teachers' perceptions of institutional support for professional development.

Challenges related to technological infrastructure in schools.

Suggestions for improving information literacy in primary schools.

**Data Collection Procedures**

Quantitative Data Collection: The survey was administered online to 150 teachers across the selected educational settings. The teachers were given 3 weeks to complete the survey, with reminders sent at regular intervals. The survey data were collected anonymously to ensure participant confidentiality.

Qualitative Data Collection: The in-depth interviews were conducted with 30 teachers who were selected based on their survey responses. These interviews were conducted in-person or via video call, depending on the teachers' preferences. Each interview lasted approximately 45 minutes and was audio-recorded with participants' consent. The interviews were transcribed verbatim for analysis.

**Data Analysis**

Quantitative Data Analysis: The quantitative data were analyzed using SPSS software. Descriptive statistics (means, standard deviations, frequency distributions) were used to summarize the survey responses and identify patterns in teachers' information literacy levels. To explore the relationships between variables, multiple regression analysis was conducted. This analysis examined the impact of factors such as frequency of technology use, professional development participation, and access to technological resources on teachers' self-reported information literacy.

Assumptions for regression analysis, such as linearity, homoscedasticity, and multicollinearity, were checked. Missing data were handled using multiple imputation, and the regression models explained significant variance in the data ($R^2 = 0.65$, $p < 0.01$).

Qualitative Data Analysis: The qualitative data were analyzed using thematic analysis (Braun & Clarke, 2006). This approach involved coding the interview transcripts to identify recurring themes related to the challenges and enablers of information literacy development among teachers. The analysis followed an inductive approach, allowing the themes to emerge from the data. Key themes included:

**Perceptions of digital skills.**

The availability and quality of professional development.

Technological infrastructure challenges.



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Suggestions for enhancing information literacy.

Thematic coding was performed by two independent researchers to ensure consistency, and any disagreements were resolved through discussion.

**Ethical Considerations**

This study adhered to ethical guidelines established by the Institutional Review Board (IRB). Informed consent was obtained from all participants, and they were assured that their participation was voluntary and confidential. Participants were informed that they could withdraw from the study at any time without penalty. Data confidentiality was maintained by anonymizing survey responses and interview transcripts, and all audio recordings were securely stored.

**Methodological Limitations**

While the mixed-methods approach provides a comprehensive understanding of the research problem, it is important to acknowledge some limitations:

Sampling Bias: The purposive sampling strategy, while ensuring diversity across settings, may limit the generalizability of the findings to all primary school teachers.

Self-Reported Data: The reliance on self-reported survey data may introduce bias, as teachers may overestimate their digital competencies.

Limited Sample Size: Although 150 teachers were surveyed, the qualitative interviews involved only 30 participants, which may not fully capture the diversity of experiences and perspectives.

Despite these limitations, the methodological approach is robust and allows for an in-depth exploration of the factors influencing information literacy among primary school teachers.

## Results

The Results section presents both the quantitative and qualitative findings of the study. This section is organized to directly address the research objectives, providing both descriptive statistics and thematic analysis to offer a comprehensive understanding of the current state of information literacy among primary school teachers in smart education environments.

**1. Technological Skills and Usage**

The survey results show that the majority of primary school teachers in the study possess basic technological skills, such as using digital tools for classroom activities and navigating online resources. Descriptive statistics reveal that:

85% of teachers reported using digital tools for basic classroom activities (e.g., presentations, videos).

60% of teachers reported regularly navigating online educational resources to gather information for lessons.

However, there is a notable gap in their ability to critically assess and integrate digital content into their teaching practices. Only 35% of teachers indicated that they regularly use technology to enhance student learning outcomes, suggesting that while they have access to digital resources, many teachers still rely primarily on traditional teaching methods.

**Table 1** Frequency of Technology Use in Classroom Activities

| Technology Use Activity | Percentage of Teachers (%) |
|---|---|
| Using digital tools for classroom activities | 85% |
| Navigating online resources for lessons | 60% |
| Using technology to enhance student learning | 35% |

**2. Challenges with Professional Development and Technological Change**

Qualitative findings from the interviews revealed significant challenges that teachers face in keeping up with the rapid pace of technological change. Many teachers expressed feeling overwhelmed by the



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continuous introduction of new digital tools and resources. For example, one teacher (Pseudonym: Emma) stated:

"I just can't keep up with all the new technology. There's always something new to learn, and we don't have enough time or training to incorporate it effectively into our lessons."

Several teachers voiced concerns about the lack of structured professional development programs focused on the integration of digital technologies. The available programs were often criticized for being too generic or not addressing the specific challenges faced in primary school contexts. John, a teacher with 12 years of experience, commented:

"The training we get is often too broad, and it doesn't really apply to the unique needs of primary school teaching. We need more hands-on, practical workshops that show us how to use technology to improve learning outcomes for younger students."

This theme highlights the need for more targeted and practical professional development opportunities tailored to the specific needs of primary school teachers.

**3. Impact of Technological Infrastructure on Teaching Practices**

Teachers working in rural or underfunded schools highlighted significant challenges related to inadequate technological infrastructure. These challenges were especially pronounced in rural schools, where teachers reported unreliable internet access, outdated devices, and limited support for maintaining or upgrading technological resources. Maria, a teacher in a rural school, shared:

"We are lucky if the internet works properly during lessons. And our devices are outdated—some of them don't even support the latest apps or software. This makes it incredibly hard to incorporate technology into my teaching, even when I want to."

These issues significantly hindered teachers' ability to integrate technology into their teaching practices, even when they were motivated and willing to do so. This finding emphasizes the importance of improving technological infrastructure, particularly in rural and underfunded schools, to support effective teaching with digital tools.

**4. Influence of Experience and Institutional Support**

Both quantitative and qualitative data revealed that prior experience with technology and institutional support play crucial roles in teachers' information literacy. Teachers with more experience using digital tools were generally more confident in their ability to integrate technology into their teaching. For example, a regression analysis showed a positive correlation ($r = 0.58$, $p < 0.01$) between years of experience with digital tools and teachers' self-reported digital competencies.

In contrast, teachers with limited prior experience or those working in environments with fewer resources struggled more with incorporating technology effectively. Sarah, a newer teacher with less than 3 years of experience, expressed:

"I feel like I don't have the skills to use technology in a meaningful way. I try, but it's hard when I haven't received much formal training."

Moreover, the analysis highlighted that institutional support, such as access to professional development and adequate technological resources, was crucial for enhancing teachers' ability to use technology effectively in the classroom. A regression analysis found that institutional support accounted for 35% of the variance in teachers' ability to integrate digital tools into their teaching practices ($R^2 = 0.35$, $p < 0.01$). Teachers who reported receiving more support from their schools and administrators were more likely to use technology to enhance student learning outcomes.

**Table 2** Influence of Institutional Support on Technology Integration

| Type of Institutional Support | Percentage of Teachers Reporting Positive Impact (%) |
|---|---|
| Access to professional development | 72% |
| Availability of technological resources | 68% |
| Leadership support | 56% |



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Integration of Quantitative and Qualitative Findings

The combination of quantitative and qualitative findings allows for a richer understanding of the challenges faced by primary school teachers in developing their information literacy. For example, while the survey data highlighted that only 35% of teachers use technology to enhance student learning outcomes, qualitative data revealed that many teachers are motivated to use digital tools but are hindered by inadequate professional development and technological infrastructure.

Unexpected Findings

One unexpected finding was the lack of consistent correlation between teachers' self-reported digital skills and their perceived impact of technology on student learning. While teachers in urban schools reported higher self-reported digital skills, they did not always perceive a greater impact of technology on student learning compared to their rural counterparts. This suggests that the perceived impact of technology on teaching may not always correlate directly with technological proficiency, and other factors—such as access to resources or teaching support—may play a more significant role in influencing learning outcomes.

The results of this study highlight several key factors influencing the development of information literacy among primary school teachers in smart education environments. While many teachers possess basic technological skills, there are significant gaps in their ability to critically evaluate and integrate digital content into their teaching practices. Challenges such as insufficient professional development opportunities, inadequate technological infrastructure, and varying levels of institutional support were found to significantly hinder teachers' ability to effectively integrate technology into their teaching. These findings suggest that enhancing teachers' information literacy requires not only improving their digital skills but also addressing the contextual challenges they face, particularly in rural and underfunded schools.

## Discussion

This study aimed to explore the development of information literacy among primary school teachers in smart education environments, focusing on the challenges and factors influencing its enhancement. The findings reveal several critical issues related to teachers' technological competencies and the support structures necessary to foster these skills. In this section, the results are interpreted in light of the data, theoretical frameworks, and existing literature, followed by a discussion of methodological limitations and implications for future research.

### *1. Gap Between Technological Skills and Pedagogical Integration*

As shown in our survey results, while many primary school teachers possess basic technological skills—such as using digital tools for classroom activities and navigating online resources—there is a significant gap in their ability to critically assess and integrate these tools into their teaching practices. Specifically, 35% of teachers reported regularly using technology to enhance student learning outcomes, suggesting that, despite access to digital tools, many teachers continue to rely predominantly on traditional teaching methods.

This finding aligns with the work of Becker et al. (2023), who found that many teachers, despite possessing technological skills, struggle to incorporate these tools meaningfully into pedagogical contexts. Our findings suggest that the lack of critical thinking skills and pedagogical knowledge necessary for the effective use of digital tools may be a key factor in this gap. The TPACK framework (Mishra & Koehler, 2006) supports this by highlighting that technological competence alone is insufficient without the integration of content knowledge and pedagogical strategies.

Our findings indicate that teachers who lack confidence in critically evaluating digital resources often revert to traditional methods, which limits the potential of smart education tools. As noted by Wilson et al. (2021), this reliance on traditional methods is not due to a lack of desire to adopt technology but is primarily driven by insufficient training in how to use these tools effectively for enhancing student learning outcomes.

### *2. Institutional Support and Professional Development*

The study reveals that institutional support plays a pivotal role in enhancing teachers' information literacy. Teachers who had access to professional development opportunities and sufficient resources



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reported higher levels of digital competency and were better able to integrate technology into their teaching practices. This aligns with previous studies, such as Zhu et al. (2022), which found that teachers' confidence in using technology is strongly correlated with the quality of professional development programs and institutional support.

However, as the interview data revealed, there is a significant disparity in access to these opportunities, especially for teachers in rural or underfunded schools. Teachers in these settings face numerous challenges, including limited access to both technological resources and training opportunities, which hinders their ability to develop their information literacy. These findings resonate with Wu and Lin (2024), who highlighted that the digital divide, particularly in rural areas, exacerbates the challenges faced by teachers in fully leveraging technology for teaching.

Actionable Recommendation: To address this gap, educational policymakers should ensure that professional development programs are equitable and accessible to all teachers, regardless of their geographical location. Additionally, school leaders should prioritize the integration of technology into professional development curricula to ensure that teachers are equipped with the skills to use digital tools effectively in the classroom.

***3. Technological Infrastructure and Its Impact on Teaching Practices***

The data from the interviews also underscore the crucial role of technological infrastructure in enabling effective teaching practices. Teachers working in rural or underfunded schools highlighted significant challenges related to inadequate infrastructure, including unreliable internet access, outdated devices, and insufficient technical support. These challenges were particularly pronounced in rural settings, where teachers reported that poor technological infrastructure severely hindered their ability to integrate technology into their classrooms.

As Maria (a rural teacher) expressed, "We are lucky if the internet works properly during lessons. And our devices are outdated—some of them don’t even support the latest apps or software. This makes it incredibly hard to incorporate technology into my teaching, even when I want to."

These findings align with those of Huang et al. (2021), who noted that technological infrastructure issues are a major barrier to the effective use of digital tools in education. The lack of reliable internet and modern devices prevents teachers from fully engaging with the potential of smart education environments.

Actionable Recommendation: To address these issues, governments and educational authorities should invest in upgrading technological infrastructure, particularly in underfunded and rural schools. Ensuring that all schools have access to high-speed internet, modern devices, and technical support is crucial for enhancing teachers' ability to use technology effectively in their teaching.

***4. A Holistic Approach to Enhancing Information Literacy***

The findings of this study underscore the need for a holistic approach to enhancing teachers' information literacy. Enhancing teachers' digital skills requires more than just providing isolated training sessions. As highlighted by Gunter (2021), effective integration of technology into teaching requires a coordinated effort that involves policy changes, targeted professional development programs, and substantial improvements in the technological infrastructure across schools.

Our study suggests that focusing solely on individual competencies is insufficient. A comprehensive framework should also consider institutional support and technological infrastructure as integral components of the information literacy development process. This view is consistent with the DigCompEdu Framework (European Commission, 2020), which emphasizes the importance of integrating individual competencies with institutional and technological contexts to foster teachers' digital literacy.

Actionable Recommendation: Educational policies should prioritize a systems-level approach that integrates individual teacher competencies, institutional support, and technological infrastructure. Schools should create supportive environments where teachers feel empowered to experiment with new technologies, backed by continuous professional development and robust infrastructure.

***5. Lifelong Learning and Ongoing Support***



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Another important theme that emerged from the data is the need to foster a culture of lifelong learning within schools. The findings suggest that teachers should view information literacy as a continuous process of growth, with regular opportunities to update their skills and adapt to emerging technologies.

As Sarah (a teacher with less experience) explained, "I try, but it's hard when I haven't received much formal training." Teachers who feel unsupported or inadequately trained may not be motivated to engage with technology in meaningful ways, underscoring the need for ongoing support and learning opportunities.

This finding is consistent with the work of Becker et al. (2023), who argue that technology integration must be an ongoing process that is supported by continuous professional development and collaborative learning communities.

Actionable Recommendation: Schools and educational policymakers must create systems that promote ongoing learning and professional development. This can be achieved by offering flexible, ongoing training opportunities, establishing peer learning communities, and encouraging collaboration among teachers to share strategies, troubleshoot challenges, and stay updated on new technologies.

**6. Methodological Limitations and Future Research**

While the study provides valuable insights into the development of information literacy among primary school teachers, several limitations must be considered. The purposive sampling method, while ensuring diversity across settings, may limit the generalizability of the findings. Additionally, the use of self-reported data in the survey may introduce bias, as teachers may overestimate their digital competencies. Future research should explore longitudinal studies to examine how teachers' information literacy evolves and the long-term impact of professional development programs. Further studies could also explore cross-cultural comparisons to investigate how different educational systems and contexts influence the development of information literacy.

In summary, the development of information literacy among primary school teachers in smart education environments requires a multi-faceted approach that includes enhancing individual competencies, providing institutional support, improving technological infrastructure, and fostering a culture of lifelong learning. By addressing these key factors, policymakers and educational leaders can better support teachers in integrating technology into their teaching practices and ensure that they are equipped to meet the demands of the digital age.

## Conclusion

This study provides valuable insights into the current state of information literacy among primary school teachers in smart education environments. Our findings suggest that while many teachers possess basic technological skills, there remains a significant gap in their ability to effectively integrate digital tools into their teaching practices. Despite the availability of digital resources, teachers struggle to leverage these tools meaningfully due to a lack of comprehensive training and support.

Regarding our first research objective—to assess the current state of information literacy among primary school teachers—our findings indicate that, although teachers have foundational digital skills, their ability to apply these skills in pedagogically effective ways is limited. Only 35% of teachers reported regularly using technology to enhance student learning outcomes, highlighting the gap between technical proficiency and effective classroom integration.

The second objective, which focused on identifying the factors influencing information literacy development, revealed that key barriers include insufficient professional development opportunities, limited access to advanced technological resources, and the digital divide between urban and rural schools. Teachers in rural or underfunded schools face the greatest challenges due to unreliable internet access, outdated devices, and a lack of institutional support. These disparities exacerbate the challenges in digital tool integration, limiting the effectiveness of smart education initiatives.

The third objective—proposing strategies for enhancing information literacy—calls for a comprehensive, systematic approach. Based on our findings, we recommend that educational policies



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emphasize continuous professional development that integrates both technical and pedagogical aspects of digital tool usage. Moreover, schools need to provide reliable internet access, modern devices, and ample opportunities for teachers to engage in long-term, hands-on training. Addressing these factors can create a more supportive environment for teachers to adopt and effectively integrate technology into their teaching practices.

This study contributes to the field by emphasizing the multifaceted nature of information literacy development, which requires not only individual teacher competencies but also institutional support and technological infrastructure. The findings underscore the need for policy changes that ensure equitable access to resources and professional development opportunities, particularly for teachers in rural and underfunded schools.

While the study provides valuable insights, it also has limitations. The sample size, although representative, may not fully capture the diversity of experiences across different educational systems. Additionally, the reliance on self-reported data may introduce bias regarding teachers' perceived digital competencies. Future research could address these limitations by exploring longitudinal data and conducting cross-cultural comparisons to assess the impact of different educational systems on teachers' information literacy development.

In conclusion, enhancing teachers' information literacy in smart education environments requires a comprehensive approach that involves targeted professional development, improved technological infrastructure, and policy changes to address disparities in resource access. By focusing on these key areas, we can create an educational landscape where all teachers are equipped to integrate technology effectively, ultimately benefiting students and improving the quality of education.

Future research should investigate the long-term impacts of professional development programs on teachers' information literacy and explore the effectiveness of peer learning communities in fostering digital competencies. Additionally, studies examining the impact of infrastructure improvements on technology integration in underfunded schools would provide valuable insights into addressing the digital divide.

**Recommendation**

Based on the findings of this study, the following recommendations are proposed to enhance the information literacy of primary school teachers. These recommendations are directly informed by our empirical findings and are designed to address the key challenges identified in the study.

***1. Increase Access to Professional Development***

Findings: The study found that only 35% of teachers reported regularly using technology to enhance student learning outcomes, suggesting a gap in teachers' ability to integrate technology into their teaching practices effectively. Teachers also reported that professional development programs were insufficient and often lacked practical, hands-on strategies.

Recommendation: Schools and educational authorities should invest in regular, targeted professional development programs. These programs should:

It will be offered every quarter to provide continuous support for teachers.

Focus on the integration of digital tools into pedagogy, emphasizing how technology can enhance student engagement, foster critical thinking, and improve learning outcomes.

Include hands-on training that allows teachers to directly apply what they learn in their classroom settings.

Offer ongoing mentorship to support teachers after the training, ensuring they have guidance as they implement new tools and techniques.

Tailor these programs to the teachers' current digital competence levels—beginning with foundational training and advancing to more complex pedagogical strategies as teachers develop confidence.

***2. Enhance Technological Infrastructure***



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Findings: The study revealed that teachers in rural or underfunded schools face significant barriers due to inadequate technological infrastructure, such as unreliable internet access and outdated devices, which hinder their ability to integrate technology into their classrooms.

Recommendation: To ensure that all teachers have access to the resources they need, educational authorities should:

Prioritize upgrading infrastructure in underfunded schools, focusing on providing reliable high-speed internet and modern devices (e.g., tablets, interactive whiteboards, educational software).
Establish dedicated technical support teams to assist teachers with troubleshooting and maintaining equipment, ensuring that technological issues do not impede teaching.

Ensure uniform access to these resources across all schools, regardless of geographic location or funding, to eliminate disparities in educational opportunities.

Implementation Timeline: Infrastructure improvements should be prioritized in the short-term (1–2 years) for schools with the most pressing needs, while long-term efforts should focus on sustainability and scaling these resources.

***3. Promote Collaborative Learning***

Findings: Teachers reported the need for more opportunities to collaborate with peers and share best practices. Peer learning communities can help teachers build confidence and stay updated on the latest technological developments.

Recommendation: Schools should facilitate regular collaborative learning opportunities by:
Organizing monthly workshops where teachers can share experiences, strategies, and challenges in using digital tools.

Creating online communities where teachers can discuss challenges, share resources, and learn from one another.

Implementing cross-school collaborations that allow teachers from different schools to exchange ideas and strategies, particularly in rural or isolated areas.

Implementation Timeline: Begin implementing peer learning communities in the short term (6–12 months), with long-term growth into more formalized networks and cross-school collaborations.

***4. Ensure Equitable Access to Resources***

Findings: The study highlighted a digital divide between urban and rural schools, with teachers in underfunded schools facing greater challenges due to limited access to technology and training opportunities.

Recommendation: Policymakers must address the digital divide by:

Providing subsidies or financial support to schools in disadvantaged areas to help them purchase modern technological equipment.

Exploring partnerships with technology companies to provide schools with affordable devices, internet services, and digital content.

Establishing grants for rural and underfunded schools to create equitable access to digital tools and resources.

Implementation Timeline: These initiatives should be prioritized in the short term (6–12 months) to address immediate disparities, with long-term efforts focused on ensuring sustainable, equitable access to resources.

***5. Foster a Culture of Lifelong Learning***

Findings: Teachers reported that ongoing professional development was crucial to improving their digital competencies. However, there was also a need for a culture of continuous learning, where teachers are encouraged to keep updating their skills.

Recommendation: Educational authorities should foster a culture of lifelong learning by:

Providing access to online courses and professional learning communities that teachers can engage with at their own pace.



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Offering flexible workshops that align with teachers' schedules, ensuring that training does not disrupt their teaching responsibilities.

Encouraging self-directed learning by providing teachers with resources and tools to assess their own competencies and track their progress over time.

Implementation Timeline: This should begin with the introduction of flexible, online professional development programs in the short term (1 year) and extend to include a formalized structure for ongoing learning throughout teachers' careers.

***6. Addressing Feasibility Challenges and Barriers***

While these recommendations offer significant potential to improve teachers' information literacy, several feasibility challenges must be considered:

Resource Constraints: Schools in rural and underfunded areas may face difficulties accessing the funds needed to upgrade infrastructure or provide continuous professional development. These barriers can be addressed through targeted subsidies, public-private partnerships, and innovative funding models.

Institutional Resistance: Some teachers may resist adopting new technologies due to unfamiliarity or perceived difficulty. This can be mitigated by offering peer mentoring and success stories from early adopters, as well as creating a supportive environment that encourages experimentation.

***7. Differentiating Recommendations for Stakeholders***

Each recommendation should be tailored to specific stakeholders:

Teachers: Should be empowered to take ownership of their professional development by engaging in self-assessment, joining professional learning communities, and seeking out peer support.

School Administrators: Should prioritize equitable resource distribution and create opportunities for collaboration and ongoing professional development.

Policymakers should focus on enacting policies that ensure equitable access to resources, support infrastructure development, and encourage continuous professional development for teachers.

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