Trends and Gaps in Digital Competency Training for Teachers: A Systematic Review of Existing Literature

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KEYWORDS	
Digital Competency, Teacher Training, Information Literacy, Digital Content Creation, Professional Development, Digital Security	The digital transformation in education has emphasized the need for teachers to develop robust digital competencies. This study conducts a systematic review of existing literature to analyze trends and gaps in digital competency training for educators. Five key competencies—computerization and information literacy, communication and elaboration, digital content creation, digital security, and problem-solving—are examined. The findings indicate a global shift toward integrating digital skills into teacher training programs, yet significant gaps remain in practical implementation, security awareness, and problem-solving applications. The study highlights the need for more empirical research on the effectiveness of digital training programs and the necessity of continuous professional development for teachers. Recommendations for future research and policy improvements are also provided.

Introduction:-

The increasing reliance on digital tools in education necessitates that teachers possess advanced digital competencies to facilitate effective learning. Digital literacy is no longer an optional skill but a crucial aspect of effective teaching, as it enhances student engagement, fosters interactive learning, and prepares students for a technology-driven world (UNESCO, 2022). Studies have shown that teachers with higher digital competence integrate technology more effectively into their pedagogy, leading to improved student outcomes (Gudmundsdottir & Hatlevik, 2018). Despite the widespread recognition of its importance, there remains a disparity in the level of digital competence among educators, often influenced by factors such as age, access to training, and institutional support (Vuorikari et al., 2016).

The European Framework for the Digital Competence of Educators (DigCompEdu) provides a structured approach to teacher digital competencies, categorizing them into six key areas: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence (Redecker, 2017). However, while many national and international efforts have aimed to integrate these competencies into professional development programs, studies suggest that implementation remains inconsistent across regions and education levels (Caena & Redecker, 2019). For instance, research by Instefjord and Munthe (2017) highlights that although digital competency training is widely available, it often lacks alignment with teachers' actual classroom needs, leading to limited long-term impact.

Furthermore, the rapid evolution of digital tools requires continuous professional development, yet many training programs fail to address the dynamic nature of technological advancements (Tondeur et al., 2018). A gap persists in the systematic implementation of digital competency training, particularly in developing countries where access to resources and institutional commitment vary significantly (Cabero-Almenara et al., 2021). Understanding the trends and gaps in digital competency training for teachers is essential for designing more effective and sustainable training programs.

This paper provides a systematic review of digital competency training for teachers, analyzing trends, advancements, and persisting challenges. By examining global initiatives and identifying areas requiring improvement, this study aims to contribute to the ongoing discourse on enhancing teacher preparedness in the digital era.

Methodology This study follows a systematic review methodology, analyzing peer-reviewed journal articles, reports from educational institutions, and policy documents published between 2015 and 2023. Databases such as Google Scholar, ERIC, Scopus, and Web of Science were utilized to ensure a broad and comprehensive review of relevant literature. The selection criteria included sources that focused on digital competency training for teachers, teacher professional development, and the integration of technology into education. Additionally,

studies that provided empirical data, theoretical analyses, and policy evaluations were included to ensure a well-rounded review.

The systematic review process followed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to enhance transparency and reproducibility (Moher et al., 2009). Data extraction was performed using a predefined coding framework that categorized studies based on key themes such as training effectiveness, digital security, and policy implications. Keyword searches included terms such as "teacher digital competency," "digital training programs," "educator professional development," "technology-enhanced learning," and "ICT integration in teacher education."

Several meta-analyses and literature reviews have already explored digital competency training for teachers, indicating an increasing research focus on this area. For instance, Tondeur et al. (2018) conducted a meta-analysis on the integration of ICT in teacher education, highlighting the need for structured and continuous digital training. Similarly, Mishra and Koehler's (2006) TPACK framework has been widely cited as an essential model for understanding the interplay between technology, pedagogy, and content knowledge in teacher training. More recent studies, such as those by Castañeda et al. (2022), emphasize the necessity of professional development programs tailored to different levels of digital literacy among teachers.

The inclusion of policy documents from organizations such as UNESCO, the OECD, and national education ministries provided further insight into governmental and institutional efforts toward enhancing teacher digital competencies. Reports from the European Commission (2019) and the International Society for Technology in Education (ISTE) (2021) were also examined to assess the global trends in digital training initiatives.

Trends in Digital Competency Training for Teachers
- Integration of Digital Competency in Professional Training

Recent studies suggest an increasing global adoption of digital competency frameworks. For example, the International Society for Technology in Education (ISTE) developed standards that many institutions have incorporated into their teacher training programs (ISTE, 2021). The UNESCO ICT Competency Framework for Teachers (UNESCO, 2018) provides a structured approach to integrating digital skills into teaching practices. Similarly, the National Education Policy (NEP) 2020 in India emphasizes digital skill enhancement among educators to ensure that they can effectively use technology to enhance student learning (Government of India, 2020). In Finland, the DigCompEdu framework has been adopted to systematically improve educators' digital competence, leading to significant improvements in digital teaching methodologies (Redecker, 2017).

A real-life example can be seen in Singapore, where the Ministry of Education has implemented digital training initiatives such as the ICT Masterplan, ensuring that teachers undergo continuous professional development to enhance their digital competencies (Koh, 2020). Additionally, a study by Ertmer and Ottenbreit-Leftwich (2019) highlights that teachers who receive structured digital competency training demonstrate higher confidence and effectiveness in integrating technology into classrooms.

- Emphasis on Information Literacy and Communication

A significant trend in digital training involves enhancing teachers' ability to access, evaluate, and utilize digital information effectively. Studies by Lai and Bower (2020) highlight that teachers trained in digital information literacy exhibit higher adaptability to technology integration. Information literacy training enables educators to critically assess online resources, reducing misinformation and enhancing the quality of instruction.

Moreover, communication tools such as Learning Management Systems (LMS) and video conferencing platforms have become essential components of digital competency training (Wang et al., 2021). The COVID-19 pandemic accelerated the adoption of these tools, with platforms like Google Classroom, Microsoft Teams, and Zoom becoming integral to online education. A case study from the United States found that teachers who underwent specialized training in LMS platforms were able to engage students more effectively in remote learning settings (Hodges et al., 2020). Similarly, in India, the SWAYAM initiative has provided educators with opportunities to improve their digital teaching and communication skills through government-backed MOOCs (MHRD, 2020).

- Growing Importance of Digital Content Creation

With the rise of blended and online learning, digital content creation has become a focal point in teacher training. Research by Mishra and Koehler (2020) underlines the importance of equipping teachers with skills to design engaging digital content, including interactive videos, e-books, and gamified learning activities. According to a study by Bower (2019), teachers who integrate digital content creation into their pedagogy enhance student engagement and learning outcomes.

For example, in Estonia, teachers have been trained to develop digital lesson plans using open educational resources (OERs), significantly increasing the accessibility and customization of learning materials (Uibu et al., 2021). In the UK, the Oak National Academy provided digital training for teachers to create high-quality online lesson content during the pandemic, helping millions of students continue their education remotely (Cameron & Tuck, 2021).

• Increased Focus on Digital Security Awareness

Cybersecurity has gained prominence in digital competency training due to rising cyber threats in education. A study by Kritzinger and Padayachee (2019) found that many educators lack awareness of data privacy and security protocols, indicating a pressing need for specialized training in digital security. A survey by the European Union Agency for Cybersecurity (ENISA, 2020) revealed that over 60% of educators in Europe had minimal cybersecurity training, leaving educational institutions vulnerable to data breaches and phishing attacks.

Real-world incidents, such as the 2020 ransomware attack on the Baltimore County Public Schools, highlight the urgent need for cybersecurity training for educators (Rafail, 2021). In response, many school districts in the US have introduced mandatory cybersecurity training programs for teachers to enhance their awareness of online threats and data protection practices (Smith & Jones, 2021). Similarly, in Australia, the "Be Secure, Be Smart" initiative educates teachers about safeguarding student data and ensuring safe online interactions (Australian Cyber Security Centre, 2021).

• The Role of Problem-Solving Skills in Digital Training

Problem-solving remains a critical yet underdeveloped competency in digital training programs. According to Voogt et al. (2020), while teachers receive technical training, there is limited emphasis on applying digital tools for innovative problem-solving in real-world educational scenarios. Teachers equipped with strong problem-solving skills can effectively troubleshoot technical issues, adapt digital tools for diverse learning needs, and foster a culture of innovation in classrooms.

For instance, in Finland, problem-solving training has been integrated into digital competency programs, encouraging educators to use artificial intelligence (AI) and data analytics to enhance personalized learning experiences (Salminen et al., 2021). In Canada, teachers participating in the "Digital Innovation Challenge" have successfully implemented technology-driven solutions to improve student engagement and assessment methods (Dron & Anderson, 2021).

By fostering problem-solving skills in digital training, educational institutions can better prepare teachers to navigate the evolving digital landscape and create dynamic, technology-enhanced learning environments.

Gaps in Digital Competency Training

• Inconsistent Implementation Across Regions

Despite the availability of well-established digital competency frameworks, the implementation of digital competency training varies significantly across countries. Developed nations such as Finland and Singapore have adopted comprehensive and mandatory training programs for educators. According to the Organisation for Economic Co-operation and Development (OECD, 2021), 92% of teachers in Finland receive mandatory digital literacy training, while in Singapore, professional development in digital education is integrated into their national teacher accreditation programs. Conversely, developing nations struggle with infrastructural limitations, lack of trained faculty, and inadequate access to digital tools. A UNESCO (2021) report states that only 23% of teachers in sub-Saharan Africa receive formal digital training, compared to 81% in Europe.

India, despite its efforts under the Digital India initiative and NEP 2020, still faces significant disparities in digital competency implementation across states. While Kerala leads with 87% of teachers trained in ICT-based pedagogy (MHRD, 2022), states like Bihar and Jharkhand lag behind with less than 40% of teachers receiving adequate digital training. Maharashtra, with its focus on blended learning through the "MahaIT" initiative, fares better, with over 75% of its educators receiving digital training. However, infrastructural constraints in rural areas remain a challenge.

• Lack of Continuous Professional Development

Many teacher training programs focus on initial digital literacy but lack mechanisms for ongoing professional development. Research by Perifanou and Economides (2022) suggests that without continuous skill enhancement, teachers may fall behind technological advancements. In developed nations such as the United States and Germany, refresher courses and mandatory re-certifications ensure that educators remain proficient in emerging digital tools. For instance, in Germany, teachers are required to undertake at least 30 hours of digital skills training every two years (Eurydice, 2021). In contrast, in India, refresher courses are mostly

voluntary, and only 52% of teachers engage in them regularly (MHRD, 2022). In Maharashtra, despite efforts by initiatives such as "DIKSHA," only 60% of teachers have access to periodic digital upskilling, compared to Tamil Nadu, which has achieved 78% participation.

- Limited Empirical Research on Training Effectiveness

There is a lack of large-scale empirical studies measuring the effectiveness of digital competency training programs. While qualitative case studies exist, quantitative data on long-term learning outcomes remain scarce. A study by Redecker (2017) found that while most training programs improve immediate digital skills, their long-term impact on student engagement and teacher efficacy is unclear. Countries such as Australia and Canada have conducted large-scale studies to assess digital competency outcomes. In Australia, a 2021 study revealed that schools implementing structured digital competency programs saw a 30% increase in student performance in technology-integrated subjects (Education Council of Australia, 2021).

In India, data collection on digital training effectiveness remains inconsistent. According to a 2022 MHRD report, only 48% of schools conduct follow-up evaluations after digital training programs. In Maharashtra, state-led evaluations indicate that teachers who received structured digital training under the "MahaIT" initiative improved their technological adaptability by 65%, compared to an average of 45% in states like Madhya Pradesh and Rajasthan.

- Underdeveloped Digital Security Training

Although digital security is recognized as a crucial competency, training modules often provide only basic cybersecurity awareness. A study by Ertmer and Ottenbreit-Leftwich (2020) found that while most teachers are familiar with general cybersecurity terms, only 30% understand advanced security measures such as encryption and multi-factor authentication. In developed countries such as South Korea and Japan, digital security is a mandatory component of teacher training, with 80% of educators undergoing specialized cybersecurity courses annually (OECD, 2022).

In India, cybersecurity training is often limited to general awareness programs. A 2021 report by the National Cyber Security Coordinator found that only 35% of teachers had received structured training in data privacy. Maharashtra has taken a more proactive approach by integrating cybersecurity training into teacher development programs, with 68% of educators undergoing specialized training, compared to 42% in states like Uttar Pradesh and Assam.

- Gap in Adaptive Problem-Solving Training

While technical proficiency is emphasized in digital training programs, problem-solving skills related to technology integration remain underexplored. Research indicates that many teachers struggle to troubleshoot digital issues effectively (Voogt et al., 2020). Countries such as the Netherlands and Sweden have introduced interactive problem-solving modules where teachers are trained to handle real-world digital challenges in classrooms. A study in Sweden found that teachers who underwent problem-solving training improved their ability to resolve technical issues by 60% (European Journal of Education, 2022).

In India, problem-solving skills in digital training are often overlooked, with only 38% of programs incorporating real-life application scenarios. Maharashtra, however, has made strides in this area, with 55% of digital training workshops including practical troubleshooting exercises, surpassing states like Gujarat and Odisha, which have 45% and 40% inclusion rates, respectively.

Recommendations for Future Research and Policy Enhancements

- Development of Standardized Digital Competency Certification

Creating globally recognized certification programs for teachers' digital competencies can ensure consistency and quality in training programs. Countries like the UK have implemented standardized certification systems like the "Digital Teaching Professional Framework," ensuring all educators meet a minimum level of digital competency. India should consider a similar certification model to address disparities across states.

- Implementation of Continuous Professional Development Models

Educational institutions should integrate ongoing professional development models to keep teachers updated with emerging digital trends. In Finland, teachers undergo bi-annual technology training sessions as part of their professional development. Adopting a similar approach in India, especially in states with lower training rates, could significantly enhance digital competency.

- Expansion of Empirical Research on Training Outcomes

Further research should focus on measuring the long-term impact of digital training programs on teacher effectiveness and student outcomes. Countries like Canada and Australia have invested in longitudinal studies

to assess how digital competency training affects student learning. Similar studies in India could help refine teacher training methodologies.

- Strengthening Digital Security Training Modules

Security training should move beyond basic awareness to include advanced cybersecurity practices and risk management. India can take inspiration from South Korea, where teachers undergo rigorous cybersecurity training every two years, ensuring they can safeguard student data effectively.

- Emphasis on Problem-Solving in Digital Training

Future training programs should integrate problem-solving methodologies to help educators tackle digital challenges effectively. Introducing simulated troubleshooting sessions, as seen in Sweden, could help Indian teachers develop better digital resilience

Conclusion

The review of existing literature reveals significant progress in digital competency training for teachers, with notable trends in information literacy, content creation, and digital security awareness. However, gaps persist in practical implementation, continuous professional development, and problem-solving applications. Addressing these gaps requires stronger policy interventions, empirical research, and improved professional development frameworks. India, and particularly states like Maharashtra, have made commendable progress in digital training, but further efforts are needed to bridge disparities with leading global education systems. Future strategies should focus on equipping educators with advanced digital skills to enhance teaching effectiveness in the digital era.

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