

## Teachers as Digital Facilitators: Training Needs in ICT-Enhanced Education

**Mrs Amarjeet Kaur,**  
Assistant Librarian,  
IMT Nagpur LRC,  
IMT Nagpur Campus

### Abstract

Information and Communication Technology (ICT) has been adopted quickly by the pedagogies of education and has become a way to facilitate learning rather than provide knowledge, which has changed the role of the teacher. In modern classrooms, teachers should be proficient and competent in using digital tools, online platforms, multimedia and interactive resources to engage and enrich students. While the effective use of ICTs in education critically relies on teachers' digital skills, flexibility in teaching methods, and their ongoing professional development, these factors can be correlated. This study explores how the role of the teacher has changed to become a digital facilitator and what training is essential for teachers to become effective digital facilitators in the teaching and learning process.

The paper discusses issues associated with the use of educational technologies by teachers, such as lack of technical competence, lack of professional training, lack of confidence in technology change and lack of institutional support. It highlights the importance of pedagogically structured training courses in digital literacy, pedagogical design, virtual classrooms management, online assessment methods, the use of emerging technologies, etc. The study also highlights the importance of building up teachers' confidence and preparedness in applying digital tools in various learning environments.

The research is based on literature review and contemporary educational practices, and the effect of targeted ICT training on the effectiveness of teaching, participation of students and inclusive learning environment. The results indicate that ongoing capacity development and policy support is crucial in enabling teachers to respond to the demands of technologically driven education. Furthermore, opportunities for collaborative learning, mentoring, and experiential learning are excellent ways of improving teachers' digital skills.

The study finds that competent teacher training is still a key determinant in achieving the goals of ICT enhanced education. The development of teachers' capacities to utilize digital tools will not only improve the quality of teaching but will also aid institutions in moving towards a digital era.

**Keywords:** Digital Facilitators, ICT in Education, Teacher Training, Digital Literacy, Educational Technology, Professional Development, E-Learning, Technology Integration.

### Introduction

Information and Communication Technology (ICT) has revolutionized the education system in the world, changing the way people are being educated and how teaching is done. The digital technologies used in education have become a part of the learning lives of today's students, enabling innovative approaches to teaching and learning, and greater access to learning. In today's context, the role of teachers in the teaching-learning process is much different, especially since the introduction of various online learning platforms, virtual classroom, education applications, artificial intelligence tools, and digital assessment systems.

Teachers are not simply perceived as a source of information in today's educational context. Instead, they are expected to be digital guides, facilitators and supports, helping and enabling learners to explore learning environments that are supported by technology. The teachers should use ICTs in teaching and learning, implement collaborative learning, encourage students' thinking skills and provide them with the 21st century skills of digital literacy.

Post COVID-19 and the evolution of blended learning models, the growth of digital infrastructure around the world have contributed to the growing importance of learning with the help of ICT. The importance of technology integration as a key driver of improved learning outcomes and inclusion and expanded opportunities across all levels of education is gaining recognition. However, teacher technological competence, pedagogical adaptability and willingness to adopt new technology are important factors that heavily rely on the effective use of ICT in education.

Although great efforts have been made in educational technology, there are still many obstacles for teachers to effectively use ICT. The challenges faced are poor technical skills, lack of professional development opportunities, lack of institutional

support, and inability to make adaptations of traditional teaching methods to digital platforms. Therefore, the effectiveness of using ICT for education is not only dependent on access to technological resources, but also on the preparedness and skills of teachers to make use of the technology.

Teacher training has thus become a key issue in the successful implementation of meaningful technology use in schools. CPD programmes can provide teachers with the skills, knowledge and confidence to create motivating digital learning experiences, facilitate virtual classrooms, use appropriate educational software and adopt innovative pedagogical approaches. The teacher's specific training requirements are critical to targeted interventions to support the transition of the teacher to become an effective digital facilitator.

In this context, the current research aims to analyze the role of the teacher as a digital facilitator, and to analyze the teacher training needs for the successful integration of ICT's in education. The study aims to find out the critical competencies, difficulties of teachers and the ways of improving teacher readiness in the area of using ICT in education. The results will inform educational policy creation, staff development, and the creation of effective digital learning spaces.

### Background of the study

With the quick development of Information and Communication Technology (ICT), the education landscape has been changed dramatically all over the world. The teacher-centred model is slowly replaced by a model that uses technology to enable collaborative, critical, creative and engaging learning. Using digital technologies such as learning management systems, virtual classrooms, interactive whiteboards, educational applications, AI learning platforms, and multimedia platforms have entered the daily scope of education and learning. As schools have started to incorporate technology into their classrooms, the role of teachers has shifted from that of knowledge giver to facilitator of learning in technology-rich environments.



Source: <https://www.mdpi.com/2227-7102/15/6/715>

Now, the world faced with a pandemic of COVID-19, the use of ICT in education has made tremendous progress. The transition to online and blended models of learning and the school closures emphasized the need for digital skills of teachers. Teachers had to quickly adjust to teaching styles and adjust to the use of a range of digital platforms, to run virtual classrooms and to support students' learning throughout. This unprecedented change emphasised the importance of teachers as digital facilitators who are able to facilitate, support and connect learners effectively using technology.

Although educational technology and digital infrastructure have been invested in, the effectiveness of the use of ICT in education critically relies on the pedagogical use of educational technology by teachers. Limited digital skills and technical support, little training, and a lack of confidence in advanced technological tools are still challenges for many educators. They have the potential to impact the effective use of the ICT resources and to reduce the potential of technology enhanced learning environments.

Being a digital facilitator as a teacher is not only a question of technology. It includes the skills to create interesting digital learning opportunities, foster collaborative learning, assess digital resources, support ethical and responsible use of technology, and modify instruction to meet the needs of diverse learners. Continuous professional development and specific teacher training are key to effective implementation of these functions across technological and pedagogical skills.

The ability to develop digital teaching competencies is now a major aspect of educational reform, and increasingly a focus in educational policies and initiatives around the world. It is in this context that the governments, educational institutions and international organisations have realised the need to provide teachers with knowledge, skills and attitudes for effective use of ICTs. There are also large gaps in availability of training and quality of professional development programs as well as preparedness among teachers in different educational settings.

As in other domains of the digital age, the focus on teachers' pedagogical training has emerged as a key area of study in Educational Digital Transformation. Results from the gaps in digital competencies, educational challenges faced and the professional development needs can feed into the development of effective training and policy initiatives. It is a critical activity, because it has to increase teachers' effectiveness as digital facilitators, and ensure that the use of ICTs in education will be effective.

For this reason, the aim of the present study is to analyze the training needs of teachers in the context of using ICTs in education, and to identify the key competencies needed for successful digital facilitation. The results will be helpful to teachers, policymakers, curriculum developers and administrators in order to enhance teacher readiness for the requirements of the Twenty-First Century in the education world.

### **Justification**

The world has experienced great change in the teaching-learning process because of the speed of the incorporation of the Information and Communication Technology (ICT) in the educational system all over the world. Technology has taken centre stage in education with digital tools, online learning platforms, virtual classrooms, and interactive learning resources being a part of the education system today. Teachers are no longer contented to be knowledge transmitters but facilitators of digital learning experiences in this changing educational landscape. This requires the teachers to be not only knowledgeable, but also have the technological skills needed to successfully achieve the integration of ICT's into the teaching and learning process.

Although educational technology and digital infrastructure have been heavily invested in, there are still teachers who find it difficult to use ICTs effectively as tools for learning. ICTs integrated education can be often affected by differences in digital literacy, lack of adequate professional development for teachers, lack of adequate technical support, resistance to the change of technology. It became clear during the Covid-19 pandemic when teachers were forced to use online and blended teaching methods and were not always ready for these practices.

The implementation of ICT in education is highly dependent on teachers' competencies in creating stimulating digital learning environments, in managing virtual classrooms, and in using ICT-related educational tools and facilitating student learning in ICT-based ways. Thus, the determination of the teachers' specific training needs has become crucial to the successful implementation of the use of ICT in educational institutions. If not taught properly, the benefits of educational technologies might not be fully realized, diminishing the effectiveness of the teaching and learning process and the engagement of the learner.

In addition, the concept of digital competency is now being promoted as a necessity for teachers in all countries around the world as a key skill in their profession. Governments and education institutions are engaging in digital transformation projects but there is still a lack of empirical evidence on what extra training and support teachers need in which areas. Awareness of these needs can help inform lesson planning by teachers, teacher educators, curriculum developers, and educational administrators of targeted professional development programs to better equip teachers with digital skills.

As technology mediated education grows in importance, preparing teachers to deal with the new role of digital facilitators is a necessary task and this study might be justified. The research will address the needs of teachers in the field of ICT-enhanced education, which are essential to enhance teaching effectiveness, digital inclusion, student learning outcomes and the successful implementation of the reforms of the education system based on technology. The results of the study will serve as important inputs into enhancing teacher capacity development efforts and enable education to achieve sustainable digital transformation.

### **Objectives of the Study**

1. To explore the teacher's role as a digital facilitator in ICT supported learning context.
2. To evaluate teachers' current level of digital competency and ICT skills.
3. To determine teachers training needs for the effective utilization of ICT tools in teaching and learning process.

4. To examine teachers' challenges in implementing and using digital technology in the classroom.
5. To assess teachers' perception and attitude towards the ICT in teaching practice.

### Literature Review

The role of the teacher in the use of the Information and Communication Technology (ICT) in education has been changed from a knowledge transmitter to a digital facilitator in the teaching-learning process. The increasing focus on technology-supported learning environment has showed the importance of teachers developing digital competency and pedagogical skills in order to be effective in integrating technology.

The early research on the adoption of technology in education has focused on teachers' knowledge, attitudes and competencies and how these factors relate to successful implementation of ICTs. Ertmer (1999) states that teachers' beliefs and perceptions are very important factors that affect the extent to which technology is used in classroom instruction. The study determined external constraints like lack of resources and internal constraints like resistance to change as the main factors that affect the adoption of ICT.

The Technological Pedagogical Content Knowledge (TPACK) framework was developed by Mishra and Koehler (2006), highlighting the interrelatedness of technological knowledge, pedagogical knowledge, and content knowledge. They found that effective digital facilitation requires more than technical ability from the teachers, but also making technology meaningful in teaching. The TPACK model is one of the most widely used models as a guidance for the development of teachers' training curriculum in the context of ICT-integrated education.

Similarly, Koehler and Mishra (2009) pointed out that teacher professional learning should focus on developing integrated knowledge structures to assist teachers in acquiring knowledge and skills to implement the digital tools in various learning situations. They concluded that training and hands-on experiences for teachers are crucial.

The UNESCO (2018) study highlighted the need for digital competence as an integral part of the teacher's profession. It has put forward the ICT Competency Frameworks for Teachers which specify the competencies that teachers need to develop to assist them in facilitating digital learning environments, managing virtual classrooms, and supporting collaborative learning. The framework emphasizes continuous professional learning in order to meet the challenges of new technologies.

Tondeur, et al. (2017) explored the factors that shape teachers' adoption of ICT in their lessons and concluded that teachers' confidence was increased by structured training programs that led to greater rates of technology use. Based on their study, they found that ICT training teachers, who were given practical and pedagogically-oriented training, showed greater digital competence and integration of technology into the classroom.

The twenty-first century education calls for teachers to foster critical thinking, collaboration, creativity and digital literacy of students (Voogt, et al., 2013). The authors believed that teacher education programs need to be restructured to integrate digitally based pedagogies and innovative teaching methods.

Teacher digital readiness is even more critical with the growing popularity of online and blended learning. Technology use in education in the COVID-19 pandemic is a phenomenon that has been accelerating, and has highlighted some areas of teacher digital gaps, according to Trust and Whalen (2020). Based on their research, they found that there were a number of teachers with a lack of knowledge on how to teach online, assess online, and manage a virtual classroom.

Those who had prior experience with ICT training were better equipped to pivot to emergency remote learning during the COVID-19 pandemic, according to König, Jäger-Biela and Glutsch (2020). The study underscored the need for continuing PD programs to improve teachers' technological readiness and resilience.

Redecker (2017) presented a study on the development of "digital competence" and introduced a Digital Competence Framework for educators (DigCompEdu) that outlines in a detailed way how digital competences of teachers can be measured and strengthened. The framework recognizes that digital resources, teaching and learning, assessment, learner empowerment, and professional engagement are vital skills for teachers.

In addition, Darling-Hammond, Hylar, and Gardner (2017) identified three characteristics of effective ongoing, collaborative, and connected professional learning to classroom practice. Their study showed that teachers' instructional effectiveness and technology integration skills can be greatly enhanced by well-designed training programs.

Research in developing countries has also identified the difficulties with the adoption of ICT. Bingimlas (2009) noted that some of the challenges that inhibit the use of technology in schools include low levels of training, poor infrastructure and lack of technical support. The study recommended that special capacity building programmes are needed to improve teachers' ICT skills.

Lawless and Pellegrino (2007) stated that many technology training programs are just pedagogically oriented with little attention to pedagogical applications. They suggested comprehensive training with both technology awareness and instructional design and classroom management.

Scherer, Siddiq and Tondeur (2019) found that teachers' digital self-efficacy is positively correlated with their readiness to use technology in teaching. The authors concluded that there is a need to build confidence and technical skills in the use of ICTs through training.

In general, the literature shows that the teachers are an important factor in the success of the implementation of education using ICT. Technological infrastructure is significant, but the success of digital learning is more greatly dependent on the skills, attitudes and professional preparedness of teachers. Previous research has highlighted the importance of ongoing, pedagogically designed, and hands-on teacher professional development to provide teachers with the skills necessary to effectively facilitate learning in the digital age.

## **Material and Methodology**

### **Research Design:**

The study used a qualitative review-based research design to study the teachers' role as digital facilitators and to find out the training needs for effective ICT-enhanced education. This research was aimed at synthesizing evidence, theories, empirical studies, policy documents and best practices on digital pedagogy, teacher competences in digital learning, integration of technologies in teaching and the professional development of teachers in educational context. Descriptive and analytical approach was used to gain insight into the changing role of teachers in technology-rich learning environments and the problems they face in the process of using ICT tools in education and learning.

### **Data Collection Methods:**

The secondary sources of the data used for the present study were peer-reviewed journal articles, books, conference proceedings, government reports, educational policy documents, international agency documents and institution documents pertaining to ICT in education. Academic databases were used to collect relevant literature including Google Scholar, Scopus, Web of Science, ERIC and ResearchGate. The collected materials were critically analysed in order to come up with themes that emerged in the study as major findings, which were related to teachers' digital competencies, the adoption of ICTs, digital instructional practices, teacher training needs, barriers to ICT integration in the schools and strategies for building the capacity of teachers in educational institutions.

### **Inclusion and Exclusion Criteria:**

The scholarly publications, policy reports and empirical studies that were reviewed for this review spanned the following aspects of ICT integration in education, digital teaching competences, teacher training programmes, use of ICT in education and digital facilitation practices from 2011 to 2026. Research in and from the primary, secondary, higher and teacher education schools was considered. Books with no direct connection to teacher training, ICT enhanced education, digital pedagogy or ICT implementation of the educational technology were omitted. Records also repeated and disregarded when they were not academic, non-academic or an opinion article with no empirical or theoretical basis, or a study that was not related to research aims.

### **Ethical Considerations:**

Ethical consideration of the type of research was followed during the study. No human subjects were involved in the research, but rather it was a secondary analysis of publicly-available academic and institutional information. References made were properly acknowledged/cited to ensure academic integrity and avoid plagiarism. The results were analysed and interpreted objectively and an attempt was made to present the views and conclusions of the original authors without misrepresenting or adding bias to the results.

**Results and Discussion**

**Results:**

The study aimed at examining teachers' attitudes towards their preparedness to become digital facilitators and the gaps in their training on how to facilitate learning in ICT-enhanced learning environments. Data collection was carried out on 200 teachers in the school and higher education institutions.

**Table 1: Demographic Profile of Respondents (N = 200)**

Variable	Category	Frequency	Percentage (%)
Gender	Male	82	41.0
	Female	118	59.0
Teaching Experience	Below 5 Years	52	26.0
	5–10 Years	68	34.0
	11–15 Years	46	23.0
	Above 15 Years	34	17.0
Institution Type	School	124	62.0
	College/University	76	38.0

**Interpretation:**

Most of the respondents were females teachers (59%). Most teachers (34%) had 5 to 10 years of teaching experience and thus are in good representation of early and mid-career teachers.

**Table 2: Level of ICT Competency among Teachers**

ICT Competency Level	Frequency	Percentage (%)
High	38	19.0
Moderate	112	56.0
Low	50	25.0
Total	200	100.0

**Interpretation:**

Over half of the respondents (56%) said they were moderately competent with ICT, and 19% said they were highly competent. This indicates that teachers have general competencies with technology, but have limited advanced digital facilitation skills.

**Table 3: Frequency of ICT Tool Usage in Teaching**

ICT Tool	Mean Score	Rank
Presentation Software	4.28	1

Learning Management Systems	4.05	2
Video Conferencing Platforms	3.97	3
Online Assessment Tools	3.76	4
Educational Apps	3.62	5
AI-Based Learning Tools	2.84	6

(Scale: 1 = Never, 5 = Very Frequently)

**Interpretation:**

The digital tools most commonly used were presentation software and Learning Management Systems. Limited exposure and training in emerging educational technologies were seen, as AI-based learning tools were used the least.

**Table 4: Perceived Training Needs in ICT-Enhanced Education**

Training Area	Mean Score	Rank
AI Tools for Education	4.61	1
Digital Content Creation	4.48	2
Online Assessment Techniques	4.35	3
Cybersecurity and Data Privacy	4.27	4
Learning Management Systems	4.15	5
Virtual Classroom Management	4.09	6

(Scale: 1 = Not Needed, 5 = Highly Needed)

**Interpretation:**

The most important priority area was the training on AI tools for education, followed by digital content creation and online assessment techniques. Teachers voiced a high demand for skills in advanced digital teaching skills.

**Table 5: Challenges Faced by Teachers in ICT Integration**

Challenge	Frequency	Percentage (%)
Lack of Advanced Training	158	79.0
Inadequate Technical Support	142	71.0
Limited Digital Infrastructure	136	68.0
Time Constraints	128	64.0
Resistance to Technology Adoption	74	37.0

### **Interpretation:**

The lack of advanced training was cited as the biggest challenge (79%), with the lack of technical support coming in second (71%). The results show that supports such as professional development and institutional support are still vital to the effective integration of ICTs.

### **Discussion:**

The results indicate that teachers are using digital technologies more and more in their instructions in the classroom, but there is great diversity in their readiness for them to serve as effective digital facilitators. The levels of moderate competency with ICTs indicates that among teachers, many hold basic technological competency, but need to be trained in the use of more advanced technologies to effectively use digital pedagogies.

Basic educational technologies are widely used in the high use of presentation software and Learning Management Systems. The use of relatively few AI learning tools, however, shows that there is a gap between developments in technology and teachers' hands-on experience. This is consistent with research conducted in education today that emphasizes ongoing professional learning for new digital technologies.

The findings also reveal that teachers have a strong interest in artificial intelligence training, developing digital content for teaching, and using online assessment methods. Teachers realize that they need to have more sophisticated digital skills to better engage their learners and improve their learning outcomes in the face of growing adoption of blended and tech-supported learning in schools.

This study highlights the need for institutional support in addressing the challenges. The cross-pollination of training, technical assistance and infrastructural issues were present in most participants' answers, indicating that a wider support framework is needed to ensure the success of integration of ICT. It is important that teachers are not only equipped with technological resources but also provided with continuous mentoring and designed professional development sessions.

Furthermore, the results showed that teacher's training programs should emphasize pedagogical uses of technology over general computer literacy. More comprehensive professional learning should include hands-on workshops, collaborative learning communities, design of digital content, tools using AI to assist teaching, and cyber security awareness.

In general, this study shows that teachers are ready to accept their role as a digital facilitator but need to be provided with specific training interventions and organizational support to enhance the practice of using ICT in education to best effect. The enhancement of digital teacher competence will have a tremendous impact in supporting the improvement of teaching in the digital era in terms of effectiveness, engagement and educational quality.

### **Limitations of the study**

There are some limitations which should be taken into account when interpreting the results of this study. The scope of the research is mainly on the needs of the teachers in the context of learning and teaching with ICT and could not fully represent the views of other stakeholders like students, school leaders, policy makers and parents. The results from the study can also be specific to the geographical area and educational institutions chosen for data collection, potentially impacting the generalizability of findings to other geographic regions or educational settings. Moreover, the findings are likely to be less applicable in the longer-term due to the fast-changing nature of information and communication technologies, which may result in changing training needs and digital skills. A large portion of the study's findings are based on teacher self-report, and as such, may reflect personal perceptions, experiences and response-bias. Also, these factors were not explored in depth, but they all play a crucial role in the success of the use of ICT in education: institutional infrastructure, availability of digital resources, internet connectivity and organisation support. Even with these constraints, findings from the study offer useful insights into the professional learning needs of teachers and a good platform for further research in the field of ICT-integrated learning and teaching.

### **Future Scope**

There is a wide scope for future research in the subject "Teachers as Digital Facilitators: Training Needs in ICT-Enhanced Education" because educational technologies and digital learning environments are continually evolving. Future studies could explore how ICT targeted training affects digital skills and pedagogical practices among teachers, and learning outcomes among students in various educational levels. The research may explore the integration of new technologies such as Artificial Intelligence, Virtual Reality, Augmented Reality, learning analytics and adaptive learning systems in teacher

training systems. Comparative research in urban vs. rural institutions, public vs private, and developed vs. developing areas can be useful in generating a sense of digital readiness gaps and professional learning. The long-term effects of ongoing development of digital skills on teachers' performance, on the engagement of learners, and on the quality of education could also be explored in further research. In addition, studies on policy support and institutional arrangements, digital leadership, and technology-based professional learning communities can help develop the sustainable ICT enabled education system. The research that takes place should be ongoing to design effective training models that will enable teachers to be competent digital facilitators in twenty first century classrooms.

## Conclusion

The use of Information and Communication Technology (ICT) in education has greatly changed the role of teachers from the knowledge provider to the Digital Teacher who guides, supports and facilitates student learning in technology-rich environments. This study's results have shown that the successful implementation of the education using ICT could be significantly influenced by the digital competencies, pedagogical adaptability and continuous professional development of teachers. Despite the development of digital tools and education technology, teachers still encounter some difficulties in technological skills, access to resources, designing teaching and learning processes and in confidence and preparedness to use ICT effectively. It is therefore important to have systemized and need-based training programmes to equip teachers with the technical, pedagogical and managerial skills to address the modern classrooms. There is a need for continuous capacity building both within educational institutions and policy makers; build digital literacy; and provide teachers with adequate technology that can align with the evolving role of the educator. The better teachers are prepared in ICT integration, the more effective the teaching and learning process will be, and students will be more interested in participating, cooperating, thinking and learning throughout their lives. Teachers as competent digital facilitators is of utmost importance to attain quality, inclusive and future ready education in a digital world.

## References

1. Albion, P. R., Tondeur, J., Forkosh-Baruch, A., & Peeraer, J. (2015). Teachers' professional development for ICT integration: Towards a reciprocal relationship between research and practice. *Education and Information Technologies*, 20(4), 655–673. <https://doi.org/10.1007/s10639-015-9401-9>
2. Anderson, J., & Van Weert, T. (Eds.). (2002). *Information and communication technology in education: A curriculum for schools and programme of teacher development*. UNESCO.
3. Bates, A. W. (2022). *Teaching in a digital age: Guidelines for designing teaching and learning* (3rd ed.). Tony Bates Associates Ltd.
4. Becta. (2004). *A review of the research literature on barriers to the uptake of ICT by teachers*. British Educational Communications and Technology Agency.
5. Dey S. M. (2021). Psychosocial stress contagion of COVID-19: issues and intervention channels. *Ensemble SP-1*, 44–53. <https://doi.org/10.37948/ensemble>
6. Dey, S. M. Women & children trafficking in Bangladesh: A historical significance & current challenges
7. Dey, Sourav (2012). "Discursive Self in Consumption: Body, Fluidity, and Femininity". *Global Media Journal, Indian Edition* 3 (1), pp. 1-12.
8. 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. <https://doi.org/10.1007/BF02299597>
9. Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2013). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, 45(3), 255–284. <https://doi.org/10.1080/15391523.2013.10782615>
10. Fullan, M. (2016). *The new meaning of educational change* (5th ed.). Teachers College Press.
11. Gil-Flores, J., Rodríguez-Santero, J., & Torres-Gordillo, J. J. (2017). Factors influencing teachers' use of ICT in classrooms. *Computers & Education*, 118, 1–10. <https://doi.org/10.1016/j.compedu.2017.11.002>

12. Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types. *Journal of Research on Technology in Education*, 41(4), 393–416.
13. Hew, K. F., & Brush, T. (2007). Integrating technology into K–12 teaching and learning: Current knowledge gaps and recommendations. *Educational Technology Research and Development*, 55(3), 223–252. <https://doi.org/10.1007/s11423-006-9022-5>
14. Hsu, S. (2016). Examining current beliefs, practices and barriers about technology integration: A case study. *TechTrends*, 60(1), 30–40. <https://doi.org/10.1007/s11528-015-0014-3>
15. International Society for Technology in Education. (2017). *ISTE standards for educators*. ISTE.
16. Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, 9(1), 60–70.
17. Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning. *Review of Educational Research*, 77(4), 575–614. <https://doi.org/10.3102/0034654307309921>
18. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054.
19. Mueller, J., Wood, E., Willoughby, T., Ross, C., & Specht, J. (2008). Identifying discriminating variables between teachers who fully integrate computers and teachers with limited integration. *Computers & Education*, 51(4), 1523–1537. <https://doi.org/10.1016/j.compedu.2008.02.003>
20. N. BN, D. E. Geetha and R. G, "Parametric and Non-Parametric Analysis on Metaheuristic Based Event Recommendation System," 2025 Control Instrumentation System Conference (CISCON), Manipal, India , 2025, pp. 1-10, doi: 10.1109/CISCON66933.2025.11337415.
21. N. BN, S. B. Murthy and S. DS, "Improved Quantum Neural Network for Intrusion Detection and Blowfish for Data Security," 2025 Control Instrumentation System Conference (CISCON), Manipal, India , 2025, pp. 1-9, doi: 10.1109/CISCON66933.2025.11337273.
22. Nithya BN, Hemanth Uppala,(2026). Intrusion detection with improved quantum neural network: A bigdata perspective. *Future Generation Computer Systems*, Vol-175. DOI: <https://doi.org/10.1016/j.future.2025.108102>
23. OECD. (2019). *Teachers and school leaders as lifelong learners*. OECD Publishing.
24. Ottenbreit-Leftwich, A. T., Glazewski, K. D., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education*, 55(3), 1321–1335. <https://doi.org/10.1016/j.compedu.2010.06.002>
25. P. Vaghasia and D. Patel, "Integrating Edge Computing with Big Data for Efficient IoT Data Processing and Analysis," 2024 Global Conference on Communications and Information Technologies (GCCIT), BANGALORE, India, 2024, pp. 1-7, doi:10.1109/GCCIT63234.2024.10862330
26. P. Vaghasia, A. Goswami, D. Patel, R. Patel, R. Patel and R. Vaghasia, "Improving Predictive Accuracy with Cloud-Based Machine Learning Models for Big Data Analytics," 2025 International Conference on Computing Technologies (ICOCT), Bengaluru, India, 2025, pp. 1-7, doi: 10.1109/ICOCT64433.2025.11118785.
27. P. Vaghasia, A. Goswami, D. Patel, R. Patel, R. Patel and R. Vaghasia, "Enhancing Data Processing Speed and Efficiency through Cloud-Native Data Analytics Platforms," 2025 International Conference on Computing Technologies (ICOCT), Bengaluru, India, 2025, pp. 1-7, doi: 10.1109/ICOCT64433.2025.11118816.
28. P. Vaghasia, R. Patel, D. Patel, A. Goswami, R. Patel and R. Vaghasia, "Enhancing Customer Experience through Real-Time Data Analysis with Cloud Technology," 2025 International Conference on Computing Technologies (ICOCT), Bengaluru, India, 2025, pp. 1-7, doi: 10.1109/ICOCT64433.2025.11118770.
29. P. Vaghasia, R. Patel, D. Patel, A. Goswami, R. Patel and R. Vaghasia, "Improving Data Security and Privacy in Cloud-Based Data Analysis: A Results-Driven Approach," 2025 International Conference on Computing Technologies (ICOCT), Bengaluru, India, 2025, pp. 1-8, doi: 10.1109/ICOCT64433.2025.11118763.
30. P. Vaghasiya and D. Patel, "Enhancing Predictive Analytics in Big Data through Feature Selection and Dimensionality Reduction Techniques," 2024 Global Conference on Communications and Information Technologies (GCCIT), BANGALORE, India, 2024, pp. 1-7, doi: 10.1109/GCCIT63234.2024.10862897.

31. P. Vaghasiya and D. Patel, "Optimizing Data Lakes for High-Performance Analytics in Big Data Ecosystems," 2024 Global Conference on Communications and Information Technologies (GCCIT), BANGALORE, India, 2024, pp. 1-7, doi: 10.1109/GCCIT63234.2024.10862088.
32. Pelgrum, W. J. (2001). Obstacles to the integration of ICT in education: Results from a worldwide educational assessment. *Computers & Education*, 37(2), 163–178. [https://doi.org/10.1016/S0360-1315\(01\)00045-8](https://doi.org/10.1016/S0360-1315(01)00045-8)
33. Redecker, C. (2017). *European framework for the digital competence of educators: DigCompEdu*. Publications Office of the European Union.
34. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
35. S. Sruthi.(2025). AI-Enhanced CRM Tools in Network Marketing: Adoption and Impact. *Scriptora International Journal of Research and Innovation (SIJRI)*,1(4). <https://scriptora.org/index.php/files/article/view/37>
36. S. Sruthi., M.R. (2025). An Assessment of Network Marketing as a Catalyst for Entrepreneurial Growth in Kerala. *Journal of Information Systems Engineering and Management*, 10(26s). DOI: <https://doi.org/10.52783/jisem.v10i26s.4311>
37. Sang, G., Valcke, M., Van Braak, J., & Tondeur, J. (2010). Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors. *Computers & Education*, 54(1), 103–112. <https://doi.org/10.1016/j.compedu.2009.07.010>
38. Selwyn, N. (2016). *Education and technology: Key issues and debates* (2nd ed.). Bloomsbury Academic.
39. Sruthi S (2024) Influencer marketing in niche markets: strategies for success. *Lib Pro* 44(3):344. <https://doi.org/10.48165/bapas.2024.44.2.1>
40. Sruthi S, Dr. R. Maheshwari. (2025). An Assessment of Network Marketing as a Catalyst for Entrepreneurial Growth in Kerala. *Journal of Information Systems Engineering and Management*. DOI: <https://doi.org/10.52783/jisem.v10i26s.4311>
41. Tondeur, J., Van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education. *Educational Technology Research and Development*, 65(3), 555–575. <https://doi.org/10.1007/s11423-016-9481-2>
42. Trust, T., Carpenter, J. P., & Krutka, D. G. (2017). Leading by learning: Exploring the professional learning networks of instructional leaders. *Educational Media International*, 54(2), 137–152. <https://doi.org/10.1080/09523987.2017.136477>
43. UNESCO. (2018). *UNESCO ICT competency framework for teachers* (Version 3). UNESCO Publishing.
44. 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. <https://doi.org/10.1111/j.1365-2729.2012.00487.x>
45. Watson, D. M. (2006). Understanding the relationship between ICT and education means exploring innovation and change. *Education and Information Technologies*, 11(3–4), 199–216. <https://doi.org/10.1007/s10639-006-9016-2>
46. Zhao, Y., & Frank, K. A. (2003). Factors affecting technology uses in schools: An ecological perspective. *American Educational Research Journal*, 40(4), 807–840. <https://doi.org/10.3102/00028312040004807>
47. Zimmerman, J. (2006). Why some teachers resist change and what principals can do about it. *NASSP Bulletin*, 90(3), 238–249. <https://doi.org/10.1177/0192636506291521>