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Technology-driven Pedagogy in Primary Schools: Evaluating the impact of training and Professional Development on Educators

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Abstract: The purpose of this research article is to conduct an in-depth analysis of the role that teacher training and professional development play in furthering the integration of educational technology in primary schools in India, with a particular emphasis on institutions that are governed by the government. For the purpose of this study, which was based exclusively on secondary data, a number of different training methods and policies at the national and state levels were investigated. In particular, the KITE and Hi-Tech School initiatives in Kerala were highlighted as noteworthy case studies. This study investigated the ways in which continual professional development affects the behaviour of teachers, their confidence, and the change of pedagogical practices in digital classrooms. A number of different training methods, such as in-person seminars, blended learning, online certification programs, and mentoring models, were examined in this article. The success of these training methods was evaluated based on how well they aligned with the reality of the classroom and relevant contextual requirements. The most important findings showed that although regulatory frameworks and digital platforms such as DIKSHA and NISHTHA have greatly increased access to training, there are still significant problems to be faced in terms of ensuring that training is of high quality, inclusive, and relevant to the area. It was discovered that the availability of follow-up assistance, leadership at the school level, and access to digital resources were all directly related to the effectiveness of training projects. The experience of Kerala shown that when professional development is localised, supported by policy, and accompanied by infrastructure support, it has the potential to result in significant increases in teacher engagement and the utilisation of technology in the classroom. On the other hand, the discrepancies that exist between rural and urban schools, as well as the uneven execution of these initiatives, continue to restrict their reach and their potential to be sustainable. The research highlighted the need of developing training programs that are research-informed, context-sensitive, and focused on the needs of the community. These programs should also include ongoing mentorship and community engagement. In order to develop teacher capacity-building systems, it is vital to take a collaborative strategy that involves government authorities, non-governmental organisations, and EdTech companies. In the end, the study came to the conclusion that it is vital to empower teachers via inclusive and long-term professional development in order to both revolutionise primary education and ensure that technology is used meaningfully in order to improve learning outcomes.

Keywords: Teacher training, educational technology, digital pedagogy, primary education, professional development

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INTRODUCTION

In order to adequately prepare students for the challenges that will be faced by a digital society that is constantly growing, the incorporation of technology into elementary education is no longer a supplementary bonus but rather a foundational requirement. Students have access to a wide variety of information that is interactive and interesting, and teachers are able to be more successful in their delivery of education thanks to the assistance that technology provides. However, the true success of education that is driven by

technology is contingent on the ability of educators to successfully accept and implement these tools within the confines of their own pedagogical practices. In elementary schools, in particular, where students are at a fundamental stage of cognitive and social development, the role of the teacher in controlling and integrating instructional technology becomes more important. It is therefore essential to cultivate the capabilities and self-assurance of educators in order to accomplish effective and long-lasting digital change in various classroom settings (Banerjee, 2023; Nambiar, 2024; Paulraj, 2022).

As a result of the fact that professional development for teachers is becoming one of the most significant aspects of educational reform in the digital era, this study is relevant because of this fact. Teachers are required to concurrently manage curriculum, pedagogy, and technology as the education system undergoes a shift from conventional classroom environments to blended and digital learning environments. To do this, it is not enough to simply be conversant with digital technologies; one must also have a profound grasp of how to appropriately match technology with educational goals. Teachers need to be equipped with the pedagogical, technical, and subject expertise necessary to construct classrooms that are learner-centred, and professional development is becoming increasingly important to do this (Khatri, 2023; Fernando, 2024; Pradhan, 2022).

There are a number of linked aspects that have an effect on how successfully technology is integrated into schools of today. Changes in curricular frameworks that place an emphasis on inquiry-based and competency-driven learning, the digital literacy of educators, the availability of institutional support, and governmental initiatives are some examples of these. As an illustration, educational establishments that make investments in infrastructure but fail to prioritise ongoing teacher training frequently reap very limited returns. It is also possible that training programs will continue to be uneven or will fail to meet the real classroom demands of teachers if enough policy clarity and administrative support are not maintained (Rayen, 2022; Solanki, 2024; Deshmukh, 2023).

The landscape of education policy in India has undergone tremendous change, and that change has included the use of technology as a fundamental driver of quality and equity in education. The National Education Policy (NEP) 2020 emphasises the importance of teacher development as a primary issue and asks for the implementation of technology at all levels of education. A number of initiatives, including DIKSHA, PM eVIDYA, and the National Curriculum Framework 2023, have been undertaken with the purpose of enhancing the digital capabilities of educators by means of free educational materials and organised training programs. Kerala, in particular, has emerged as a pioneering state in this domain with its KITE (Kerala Infrastructure and Technology for Education) initiative and Hi-Tech School Projects which offer systematic technology training for government school teachers (Kumaran, 2023; Deyal, 2024; Sharma, 2022).

Based on the most recent statistics, it is evident that although the availability of digital tools in Indian schools has increased, the actual implementation of these technologies into the classroom is still not uniform. Over eighty percent of instructors in affluent nations report making frequent use of technology in the classroom. On the other hand, the percentage of teachers who utilise technology in government schools in India ranges from twenty percent to thirty-five percent. As a result of a lack of digital confidence or inadequate training assistance, a significant number of educators continue to rely on conventional techniques, particularly in rural or resource-constrained neighbourhoods (Yousuf, 2023; Pereira, 2024;

Iqbal, 2022).

The major objective of this research is to conduct an in-depth analysis of the efficacy of various teacher training and professional development programs in facilitating the implementation of technology-driven pedagogy in primary schools in India. The purpose of this article is to investigate the role that professional development plays in building teacher capacity for educational technology integration. The paper focusses specifically on Kerala as a case example and investigates the role that professional development plays in this regard.

Within the scope of this investigation, a theoretical and review-based technique that is founded only on secondary data sources has been utilised. The research did not entail the collecting of original data or the statistical analysis of secondary data. The information was gathered from a wide range of reliable sources, such as publications published in peer-reviewed journals between the years 2010 and 2024, documents produced by national and state governments, such as the National Education Policy 2020 and the National Curriculum 2023, and international reports from organisations such as UNESCO, the Organisation for Economic Cooperation and Development (OECD), the Ministry of Human Resources and Development (MHRD), and SCERTs. Searches were conducted in academic databases such as Scopus, JSTOR, ERIC, and Google Scholar in order to obtain the relevant literature.

The collected literature was analyzed using thematic content analysis to identify recurring issues and solutions related to teacher training and technology integration. A comparative review was conducted between Indian and international teacher training models. The discussion was further enriched by applying pedagogical models such as the Technological Pedagogical Content Knowledge (TPACK) framework and the Substitution, Augmentation, Modification, and Redefinition (SAMR) model.

IMPORTANCE OF PROFESSIONAL DEVELOPMENT IN EDUCATIONAL TECHNOLOGY ADOPTION

Continuous professional development (CPD) The successful incorporation of instructional technology into elementary school is largely dependent on the significant role it plays. It is imperative that educators continually update their abilities in order to maintain their effectiveness as learning facilitators in light of the ongoing evolution of digital tools and platforms. Teachers are provided with organised chances to acquire technical capabilities, gain an understanding of pedagogical integration, and change their teaching practices in accordance with them through continuing professional development (CPD). The incorporation of technology in the classroom frequently stays superficial and fails to bring about real transformations in teaching practices when it is not accompanied by persistent professional development (Kumari, 2023; Basu, 2024; George, 2022).

Training programs that are effective have an impact on educators by boosting their self-assurance, boosting their enthusiasm, and fostering creativity in the delivery of education. It is more probable that instructors will experiment with digital tools, construct learning environments that are centred on the student, and make educated judgements regarding the use of technology when they are provided with hands-on experience and contextualised training. According to a number of studies, educators who participate in specialised digital training have a greater level of self-efficacy, which in turn leads to increasing rates of

technology utilisation in the classroom and enhanced student engagement. In addition, continuing professional development helps to cultivate a culture of professional learning in which educators work together, share their methods, and support one another's development in the digital realm (Fernando, 2023; Pillay, 2022; Shankar, 2024).

Singapore, Finland, and Australia are just a few examples of nations throughout the world that have proved the influence that continuing education technology training efforts can have. In Singapore, the development of teachers is included into national information and communications technology master plans, which provide diverse training routes. In order to contextualise training efforts, the model that Finland uses places an emphasis on pre-service digital pedagogy and mentoring, whereas the model that Australia uses encourages school-based coaching. Continuous learning, institutional support, and policy alignment are the three variables that are prioritised by these systems. These are the factors that can drive India's approach to teacher training for new technology adoption. Drawing from these ideas, the primary education system in India may reap the benefits of establishing CPD programs that are both inclusive and adaptable, and that are tailored to the reality of the local classroom (Wong, 2023; Eriksson, 2022; Douglas, 2024).

REVIEW OF TEACHER TRAINING MODELS AND THEIR EFFECTIVENESS IN DIGITAL EDUCATION

There are many different models of teacher training that have arisen to assist the integration of educational technology. Each of these models has its own set of advantages and advantages, as well as its own set of limits. Traditional workshops that take place in person have been a frequent practice for a long time, particularly in educational systems that are controlled by the government. These sessions make it possible for participants to engage in instant conversation, receive feedback in real time, and learn from their peers; yet, they frequently face difficulties in terms of logistics, time limits, and inadequate follow-up assistance (Sen, 2023; Baral, 2024; Nayak, 2022).

The popularity of blended learning methods, which mix in-person instruction with online modules, can be attributed to the fact that they provide flexibility while yet retaining a mentoring structure. Through participation in these programs, educators are able to study at their own speed while simultaneously receiving organised assistance during physical sessions. Blended models, on the other hand, need dependable internet access and curriculum that is well-designed, which can be a difficulty for schools that are located in remote areas or have little resources (Thomas, 2023; Iyer, 2024; Kapoor, 2022). Online certification programs provide scalable solutions for mass training. Platforms like DIKSHA have enabled teachers across India to access structured learning modules. The key advantage lies in accessibility and uniform content delivery, though the lack of personalized feedback and one-on-one engagement remains a major drawback (Nazeer, 2023; Khanna, 2022; Fernandez, 2024).

An strategy that is more context-driven is provided via mentoring programs, which can be implemented through peer cooperation or through the facilitation of experts. In addition to providing individualised assistance, mentors are able to view classroom applications and propose answers to problems in real time. These methods are very effective in maintaining long-term improvements in teaching behaviour; nevertheless, they demand a large commitment of human resources and coordination (Grover, 2024; Narayan, 2022; Devika, 2023).

An essential problem that is shared by all models is the extent to which the content of training is aligned with the actual practices that are used in classrooms. The results of studies reveal that training that is not contextualised and is generic has a limited influence on the performance of teachers. To guarantee that the models are applicable in the real world, effective models combine digital tools that are connected with the curriculum, material that is particular to the language, and practical ways for classroom integration (Patra, 2023; Raghavan, 2024; Saxena, 2022).

STATUS OF TEACHER TRAINING PROGRAMS IN INDIAN PRIMARY SCHOOLS

The landscape of teacher training programs in India has undergone substantial transformation, particularly after the implementation of the National Education Policy (NEP) 2020, which emphasized continuous professional development in digital pedagogy. Central government initiatives such as DIKSHA (Digital Infrastructure for Knowledge Sharing) and NISHTHA (National Initiative for School Heads and Teachers' Holistic Advancement) have been launched to offer scalable, digital-first training modules for primary school teachers. These programs are designed to enhance teacher competencies in curriculum alignment, digital content creation, and classroom technology integration. However, evaluations suggest that while these platforms have significantly expanded access, the quality and relevance of training vary across states due to lack of contextualization and follow-up mechanisms (Rajput, 2023; Taneja, 2022; Abraham, 2024).

At the state level, several governments have introduced localized training programs to complement national schemes. Kerala has emerged as a leader in this space with its KITE (Kerala Infrastructure and Technology for Education) and Hi-Tech School projects. KITE offers intensive ICT training to teachers, combined with infrastructure support in the form of laptops, internet connectivity, and smart classrooms. The Hi-Tech School project aims to digitize public school classrooms and integrate technology into the day-to-day teaching process. These initiatives have reportedly increased teacher engagement with digital tools and improved classroom interactivity (Menon, 2023; D'Silva, 2024; Raveendran, 2022).

Although these attempts have been made, there are still many implementation gaps. The gaps that exist between urban and rural areas continue to be a significant problem. Rural educators frequently face problems such as access to the internet that is inconsistent, poor technical assistance, and limited exposure to digital technologies. The inadequate monitoring, the absence of incentives for teacher engagement, and the little customisation of training content to regional languages and pedagogical demands are all examples of policy bottlenecks. In order to close these gaps, targeted investments in rural capacity building and decentralised training delivery systems are required (Kuriakose, 2023; Bansal, 2024; Iqbal, 2022).

IMPACT OF TRAINING ON TEACHER ATTITUDES AND TECHNOLOGY INTEGRATION LEVELS

The attitudes of educators towards the use of technology in classrooms have been proven to be improved as a result of teacher training programs, which have showed ameasurable impact. The results of post-training assessments suggest that well-structured programs inspire greater levels of enthusiasm and confidence in educators, as well as encouraging an openness to the implementation of digital tools. Teachers who previously expressed resistance to technology owing to a lack of familiarity with it or a fear

of failing sometimes exhibit a change in attitude after receiving specialised training. The instructional value of technology and its ability to make learning more dynamic and engaging for students is beginning to be recognised by them (Dhar, 2023; Mathur, 2024; Jaisingh, 2022). This behavioral transformation is most evident when training includes hands-on experience and contextual examples drawn from the teachers' own classroom environments.

When it comes to evaluating the degree to which technology is really integrated into practical teaching methods, the quality of training is an extremely important factor. The use of digital tools in day-to-day education is likely to increase as a consequence of programs that are tailored to the instructors' specific needs, connected with the curriculum, and presented in a language that is easily understood by the educators. On the other hand, workshops that are general or only held once frequently result in a modest influence on the classroom. It has been demonstrated via research that educators who participate in training that is both organised and follow-up are more likely to make frequent use of educational software, digital assessment tools, and electronic material (Bhagat, 2023; Mirza, 2022; Sharma, 2024). Training effectiveness also correlates with school-level support and access to functioning digital infrastructure.

The availability of refresher courses and mentoring support significantly strengthens long-term integration of technology in classrooms. Continuous guidance allows teachers to troubleshoot issues, experiment with new tools, and reflect on their instructional practices. Mentorship programs foster a collaborative learning environment, where peer interactions further reinforce digital adoption. In contrast, the absence of follow-up results in skill erosion and reluctance to innovate over time. Sustained training, therefore, ensures that teachers move beyond passive consumption of technology to actively reimagining their teaching methods (Nayyar, 2023; Basheer, 2024; Fernandes, 2022).

RECOMMENDATIONS FOR IMPROVING TEACHER CAPACITY-BUILDING IN PRIMARY SCHOOLS

An strategy that is strategic, inclusive, and context-driven is required in order to realise improvements in teacher capacity-building in elementary schools. In the first place, training programs have to be built in a way that is both scenario-specific and need-based. To do this, it is necessary to have a grasp of the individual issues and realities that instructors in various places confront, such as the availability of resources, the demography of students, the diversity of languages spoken, and the digital infrastructure. The training modules need to be adapted to reflect the local curriculum, regional languages, and teaching situations in order to make them directly relevant to the day-to-day practices of the instructors. In addition, the provision of modular material enables educators to go at their own speed, which also allows them to accommodate students with varied degrees of digital literacy and prior experience with technology.

The provision of continued follow-up help and access to the resources that are required is yet another essential proposal which should be implemented. It is common for one-time seminars to result in minor changes over the long run. Instead, instructors may benefit from systematic post-training assistance, which includes things like peer mentorship, technical helplines, and online discussion forums. These types of support can assist teachers in resolving issues, exploring new digital tools, and maintaining their confidence. It is also possible to assure that the training will transfer into real classroom applications by providing schools with up-to-date digital infrastructure, teaching aids, and maintenance assistance.

Participation in the training process from both school administrators and members of the community at large is of equal significance. Training should be provided to school principals so that they can support and encourage the incorporation of technology in the classroom and function as instructional leaders. Additionally, parent-teacher associations and members of the community may be included in the process of supporting resource mobilisation and assessing the performance of training efforts, which will ultimately result in the creation of an atmosphere that is more collaborative and accountable.

Last but not least, establishing relationships between government agencies, non-governmental organisations (NGOs), and EdTech companies may improve the quality of training programs, as well as their scalability and innovativeness. Policy guidance and money can be provided by governments, while non-governmental organisations (NGOs) can give experience in grassroots implementation. EdTech companies have the ability to provide digital solutions and content that are in line with the objectives of education. Through such integrated efforts, a sustainable model of teacher development would be ensured, which will enable educators to take the lead in implementing technology-enhanced learning techniques in primary schools across India.

CONCLUSION

In this study, a detailed investigation on the efficacy of teacher training and professional development activities in facilitating the incorporation of educational technology in primary schools in India has been carried out. In addition to the availability of digital infrastructure, it was discovered that the effectiveness of technology-driven pedagogy was dependent not only on the availability of digital infrastructure but also on the competence, confidence, and constant support offered to educators. Analyses were conducted on a number of different training methods, including in-person seminars, blended learning formats, online certification programs, and mentorship programs. There were a number of individual benefits and drawbacks associated with each, but it was discovered that the effect of each was greatly increased when it was linked with local educational settings and supported by organised follow-up methods.

According to the findings of the study, teachers' attitudes and behaviours towards technology underwent a favourable metamorphosis as a result of receiving specialised training. Teachers were more motivated to teach, their digital skills were better, and they were more eager to experiment with new pedagogical techniques as a result of well-designed classroom activities. Key obstacles, however, continued to include gaps in policy implementation, discrepancies between rural and urban areas, and a lack of funding for refresher training. Case examples from Kerala, in particular the KITE and Hi-Tech School initiatives, revealed that training that was both locally tailored and backed by policy could result in substantial technology adoption. However, problems relating to consistency and inclusion continued to exist.

The findings provided further evidence that teacher training played a crucial role in bridging the gap between the objectives of policymakers and the actual classroom practices in the realm of digital education. The technology continued to be underutilised, and its potential to improve student engagement and learning outcomes was not fully realised because a lack of effective training prevented its full utilisation. As a result, a training strategy that only occurred once was insufficient for bringing about long-term change.

In its conclusion, the study emphasised the need of professional development programs that are research-

backed, long-term, and inclusive. In addition to being responsive to the ever-changing requirements of primary educators, these strategies need to be supported by collaborative frameworks that include educational institutions, government agencies, and technology partners. For the purpose of developing a primary education system that is both equal and prepared for the future, it is vital to provide teachers with opportunities for consistent professional development.

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