Teacher - Technology Synergy across Bloom's Three Domains: A Critical Study

Abstract

In the 21st century, technology has become an integral part of education in revamping teaching and learning processes National Education Policy 2020 and the National Curriculum Framework 2023 emphasized the role of information technology as an enabler in education as well as teachers' irreplaceable role. The integration of technology should align with the learning domains of Bloom's taxonomy of Human development to enhance learning. At this juncture, descriptive survey research was conducted among 150 phase I Secondary school teachers in Kerala to study the awareness as well as their perception of integrating technology, including AI tools, in education using an awareness test and questionnaire, respectively. The first phase of the study focused on awareness, while the second phase gathered perceptions from those who had integrated technology into their classroom practices. The findings highlighted that while a blended approach of collaboration between technology and human teachers is widely preferred in the cognitive domain, teachers remain irreplaceable in domains requiring emotional understanding, ethical decision-making, and motor skill development. The study results underscore insights for policymakers, educators, and institutions aspiring optimal utilisation of technology in Indian classrooms.

Keywords: Bloom's taxonomy, Technology integration, Education, Teachers' awareness, Teachers' perception, Indian classrooms

Introduction

One of the most influencing educational frameworks, Bloom's Taxonomy, classifies learning into Cognitive, Affective and Psychomotor domains (Bloom et al., 1956). To meet modern pedagogical needs, Anderson and Krathwohl revised the taxonomy in 2001. Various adaptations have arisen to blend digital tools into learning with the expeditious rise of technology in education. By aligning AI integration with the levels of Bloom's Taxonomy, educators can promote a balanced approach where AI supports, rather than replaces, essential cognitive processes (Pradeep, 2024). Understanding the extent of teachers' awareness of technology, its influence on usage, and perceptions of integration across Bloom's three domains is a core study area.

Technology has become a vital part of education in reshaping teaching and learning processes in 21st century. As the world becomes increasingly interconnected and reliant on digital innovation, the role of technology in education has emerged as a pivotal driver of transformative learning. Digital technologies enable interactive and engaging learning experiences, fostering student participation and critical thinking. Technology's integration in educational settings has revolutionized traditional teaching methodologies, empowering both educators and learners with innovative possibilities (Kalyani, 2024). It is important to make teaching and learning personal to students, particularly the Millennial Generation (Koeller, 2012) and generations to come. Although his claims have been deliberated, Prensky (2001) was correct in stating that future professional development should focus on the use of technology and its necessity in education. Looking at theory, technology has very many uses including: an understanding of basic operations and concepts, enhancing productivity and professional preparation and understanding of social, ethical, legal and human issues of technology use in educational institutions (Tomei, 2005). With concern to practical application technology may aid in designing efficient and effective learning environments and experiences, curricula that enhance student learning, and offer a vast number of instructional strategies (ISTE, 2003).

The National Education Policy (NEP) 2020 and the National Curriculum Framework (NCF) 2023 draw attention to the role of technology in boosting teaching, learning, and assessment. Also, the NEP 2020 envisions a holistic and learner-centric education system that leverages technology to enhance access, quality, and flexibility in education (Kumari & Nigam, 2023). According to NCF 2023, even if AI tools and digital tools offer potential, they must collaborate rather than overshadow the teachers. For enriching teachers' effectiveness and student engagement, technology should serve as a catalyst. Prime Minister Narendra Modi mirrored this vision, pointing out that the NEP aims to move education beyond narrow thought processes and integrate it with modern ideas of the 21st century. NEP 2020 highlights socio-emotional learning as a critical aspect of a student's holistic development. As teachers will have greater autonomy in pedagogy, they will also focus on socio-emotional learning. NCF 2023 emphasizes that a child's socio-emotional development impacts the other domains of development, such as physical, cognitive, and language development. As highlighted by NEP 2020, a bi-directional bond is passing on between education and technology, constructing and upgrading reciprocally in socio-emotional development is crucial.

Finding teachers' awareness of technology in education and its usage and assessing techno pedagogues' perceptions of technology integration in enhancing learning across Bloom's Cognitive, Affective, and Psychomotor domains are the purposes of this study report.

Need and Significance

Learning is categorized into three domains: cognitive, affective, and psychomotor in the taxonomy of educational objectives developed by Bloom and his colleagues in 1956. It provided a systematic framework for structuring curricula, designing assessments, and guiding educational research. For adapting Bloom's original framework to modern pedagogical practices, Anderson and Krathwohl (2001) revised it as existing the need for a more contemporary approach. However, with the rapid advancement of technology in education, various adaptations have emerged to integrate digital tools into the learning process. Despite these advancements, the extent to which teachers are aware of technology's role in education, how this awareness influences their actual usage, and how techno pedagogues perceive technology integration across Bloom's three domains remain critical areas of study. Understanding these factors is essential for effective curriculum development, teacher training programmes, and policy-making in the digital era. According to NEP 2020, while education will play a critical role in this transformation (India's transformation into a

digitally empowered society and knowledge economy), technology itself will play an important role in the improvement of educational processes and outcomes. NCF 2023 says that technology evolves and changes every generation, as it has been witnessed with radio, television, computers, internet, mobile devices, and, more recently, Artificial Intelligence (AI) including generative AI. It is abundantly clear that no technology can fix fundamental problems of resource provision, teachers' capacities and motivation, and students' readiness for schooling. The centrality of the presence of a motivated and capable teacher in every classroom in achieving educational goals, needs continued emphasis. However, with the availability and appropriate use of these technologies, the effectiveness of teachers and the experience of learners can be enhanced. Technology can be a significant enabler of improvement on multiple dimensions of the education system.

Hence, this study aimed to provide essential realisations into the synergy between teachers and technology to enrich teaching and learning outcomes.

Review of Literature

The Information and Communication Technologies Competency Framework for Teachers (ICT-CFT) was developed by UNESCO (2011) in consultation with major private actors such as ISTE, Cisco, Intel and Microsoft, and has been regularly updated since. The framework was updated in 2018. This framework specifies the competencies that teachers need to integrate in their professional practices to develop critical knowledge and awareness with their students in the digital era. The framework emphasises the role that digital technologies have in supporting six key areas of knowledge: Understanding ICT in education, Curriculum & Assessment, Pedagogy, ICT, Organisation & Administration, and Teacher Professional Learning. The framework sets three phases of knowledge acquisition: technology literacy, knowledge deepening, and knowledge creation.

AI has possibilities in personalized learning and trajectory mapping with Intelligent Tutoring Systems to expand educational learning in developing countries (Nye, 2015). AI tools, which designed not to replace teachers but to assist them by automating time-consuming tasks such as grading, tracking progress, and curriculum customization can serve as professional development resources, offering insights into effective teaching strategies based on data from student interactions (Mahadevan et al, 2024). Good teachers will continue to exist in the future, teaching classes designed to boost students' affective intelligence, creativity, and communication (Manyika et al., 2017). Individually tailored learning experiences

(Mohammed & Watson, 2019) along with providing feedback and guidance through modern artificial intelligence like ChatGPT (Sardar, 2023) can be adapted through the complementing role of artificial intelligence. Also, AI-powered platforms offer higher satisfaction when compared to traditional, one-size-fits-all instructional methods (Ayeni et al., 2024). While AI can enhance personalized learning, it cannot replace the nuanced understanding and emotional support (Mahadevan et al., 2024) due to a lack of sentience and self-awareness (Felix, 2020; Pavlik, 2023); as AI technologies have yet to automate (Schiff, 2020), emotional support from teachers is essential for student engagement and motivation (Timms, 2016) as well as for effective parent-teacher communication (Chan & Tsi, 2023). Among students, teachers build civic engagement and develop a sense of responsibility to their community and society (Chan & Tsi, 2023), trust and moral support, and help them to acquire social and emotional learning where artificial intelligence fails (Sardar, 2023) and values and social norms cannot be quantified and reduced to algorithms (Felix, 2020).

The use of digital technologies to support learning in physical education (PE) has grown in recent years (Saiz-González et al., 2024). AI systems may assist with tracking performance data or providing some instructional content, but they cannot replace the hands-on guidance and encouragement of human teachers and coaches. Also, teachers help students develop their artistic skills and appreciation for various art forms, but AI may lack the ability to inspire artistic expression and cultivate a deep appreciation for the arts (Chan & Tsi, 2023).

Objectives

1. To identify the level of awareness of technology in education among secondary school teachers (Phase I).
2. To study the extent of use of technology in education among secondary school teachers (Phase I).
3. To study perceptions of techno-pedagogues in technology integration in enhancing learning across Bloom's Cognitive, Affective, and Psychomotor domains.

Methodology

Descriptive survey method has been used for this study. The awareness test of technology was used to identify the awareness of technology in education. Subsequently, the questionnaire on the perception of teachers of technology integration was used to realise the views on technology integration.

Tools used for the study:

Test on Awareness of Technology: The test consisted of 10 items to identify awareness of technology of secondary school teachers (Phase I). The items cover areas such as basic understanding, familiarity, and application of technology in education. Additionally, the items in the test included awareness of teachers on the inclusion of technology as suggested by NCF 2023.

Questionnaire on Perception of Teachers on Technology Integration**:** The questionnaire on perception of teachers on technology integration was designed to analyse the perception of teachers on technology integration across Bloom's domains. The questionnaire consisted of 15 items, with three response options for each. The items were evenly distributed across the domains, with five items per domain.

Sample: The population for the study was secondary school teachers (Phase I) in Kerala. One hundred fifty secondary school teachers (Phase I) from three districts were taken as the sample for the first phase of the study, which identified their awareness of technology in education. From this group, teachers who demonstrated both awareness and active integration of technology in the classroom were selected for the second phase to explore their perception of technology integration across Bloom's domains.

Analysis of Data: In the first phase of the study, the data collected using a test on awareness of technology has been analysed by using a percentage analysis technique. Furthermore, in the second phase, a percentage analysis was also used to analyse the data collected by questionnaire on the perception of teachers on technology integration.

Result and Discussion

The study consisted of two phases: the first phase involved analysing data from the awareness test on technology among secondary school teachers. From this, teachers who integrate technology into the teaching-learning process were identified. In the second phase, their perceptions of technology integration in education were collected and analysed.

Phase 1

Awareness of Technology among Secondary School Teachers (Phase I)

In the first phase, the awareness of technology among 150 phase I secondary school teachers in Kerala was analysed, and based on their scores in the awareness test the awareness levels

were categorised into three groups as Low Awareness (0-4 score), Moderate Awareness (5-8 score), and High Awareness (9-10 score). Table 1 shows the results.

Table 1

Levels of Awareness among Secondary School Teachers (Phase I)

Level of Awareness	Frequency (N)	Percentage
High	**18**	**12**
Moderate	**83**	**55.3**
Low	**49**	**32.6**

From the table, it is visible that 55.3 % of teachers showed a moderate awareness, 32.6 % showed low awareness, and only 12 % of them exhibited high awareness of technology in education. This result is suggesting the need for professional development programs to improve the technological proficiency of teachers.

Among the 150, 38 teachers were found to be practicing technology integration for teaching-learning purposes and Table 2 demonstrates the number of teachers integrating technology in their teaching practices at each level.

Table 2

Technology Awareness and Practice among Secondary School Teachers (Phase I)

Level of Awareness	Frequency	Practicing Technology
High	**18**	**15**
Moderate	**83**	**23**
Low	**49**	**0**

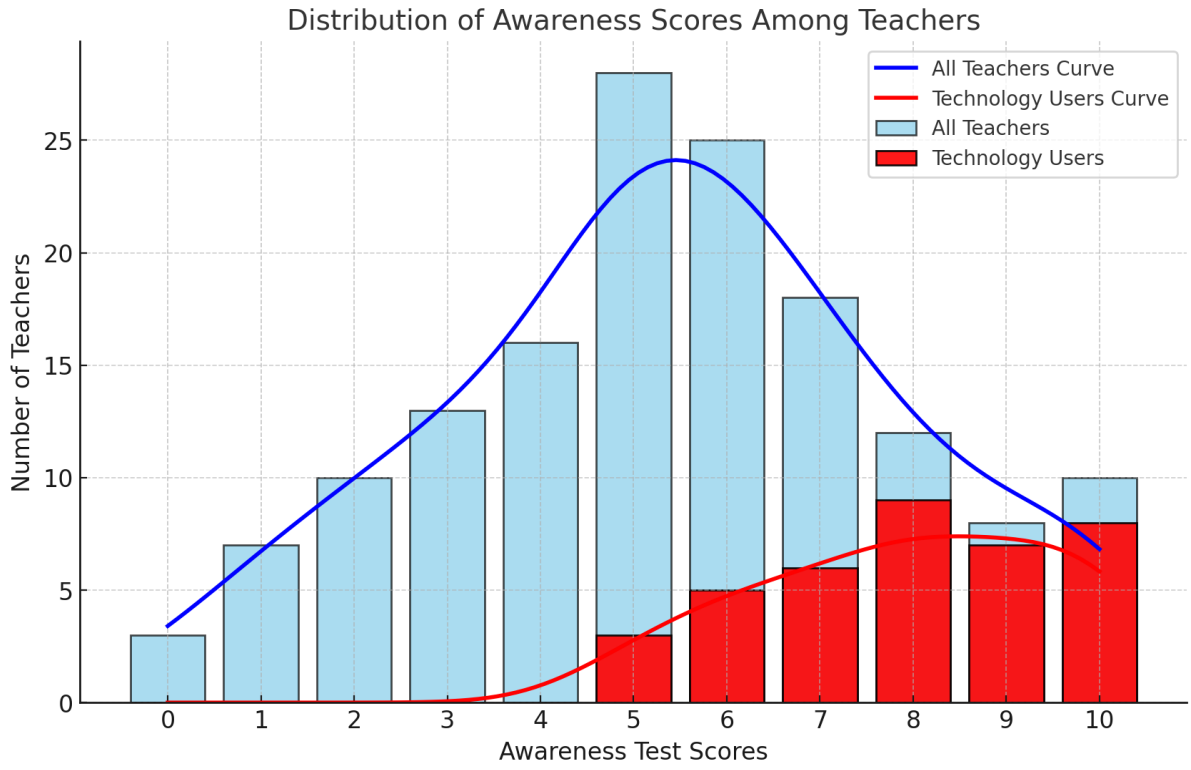
Majority (15 out of 18) of teachers with a high awareness level integrate technology. While 23 out of 83 teachers in moderate awareness level integrate technology, none of the

teachers with low awareness integrate technology in classrooms. This result is highlighting an interdependence between awareness levels and active integration of technology in teaching-learning processes.

The distribution of the awareness score on technology in education among technology practicing and technology non-practicing teacher is presented in figure 1

Figure 1

Distribution of Awareness Score on Technology in Education among All Teachers



Phase 2: Perceptions of Teachers of Technology Integration Across Bloom's Domains

The second phase focused on teachers' perceptions of technology integration in the Cognitive, Affective, and Psychomotor domains. The perceptions were collected from the 38 teachers who actively integrate technology in their teaching-learning practices by administering a questionnaire having five items per domain.

The distribution of teachers' perceptions of technology integration across Bloom's three domains is presented in Table 3.

Table 3

Teachers' Perceptions of Technology Integration Across Bloom's Domains

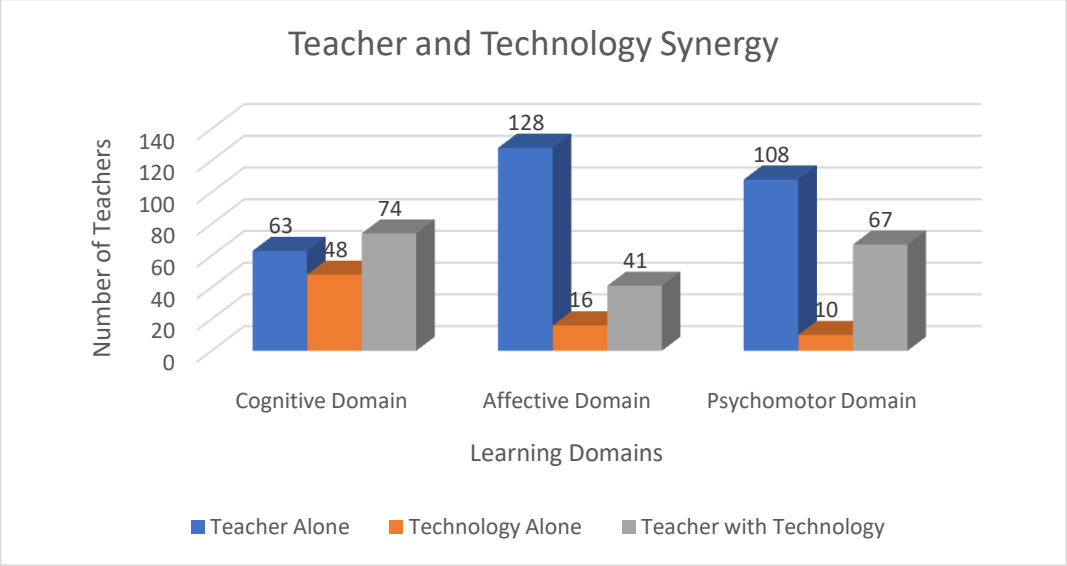
Domain	Teacher Alone		Technology Alone		Teacher with Technology	
	N	%	N	%	N	%
Cognitive	**63**	**34**	**48**	**26**	**74**	**40**
Affective	**128**	**69**	**16**	**9**	**41**	**22**
Psychomotor	**108**	**58**	**10**	**5**	**67**	**36**

The table shows that the teachers perceive blended instruction was most effective in cognitive domain while teacher alone is better in the domains of affective and psychomotor.

In figure 2, a graphical representation of perception of teachers of technology integration across Bloom's domains is presented.

Figure 2

Graphical Representation of Perception of Teachers of Technology Integration across Bloom's Domains



Interpretation of Findings

1. Cognitive Domain: In developing cognitive skills, 34 % responses indicate that teacher alone is most effective. While 26 % responses imply technology alone can make cognitive development possible more efficiently, 40 % responses indicate that a synergy between teachers and technology yields the best learning outcomes.
2. Affective Domain: A significant majority (69 %) reactions show that a teacher's role is indispensable in emotional, ethical, and social development. Only 9 % answers support technology as superior in this domain, and 22 % responses promote a blended approach. This suggests that teachers recognize the emotional and social limitations of technology.
3. Psychomotor Domain: From the result, 58 % respondants indicate that the majority prefer teacher-led instruction for skill-based and motor learning. Only 5 % replies point out that technology plays a more effective role in this domain. However, 36 % responses support an integrated approach. The importance of hands-on guidance from teachers in skill-based education is clearly visible from these revelations.

Conclusion

The findings clearly display the varied levels of awareness of technology in education among secondary school teachers (Phase I). This study indicates a strong need for structured professional development programs to strengthen their technological proficiency as a significant number have limited awareness. Teachers with limited awareness rarely adopt it in their teaching practices; meanwhile Teachers with higher awareness are more likely to

integrate technology effectively. This realisation suggests that for integrating technology meaningfully, increasing awareness is a crucial step.

The findings state that while technology enhances cognitive development, teachers play a crucial role in affective and psychomotor learning with regard to domain-specific perceptions. In the cognitive domain, a blended approach of making a collaboration between technology and human teacher is widely preferred. However, teachers remain irreplaceable in domains requiring emotional understanding, ethical decision-making, and motor skill development. Also, NEP 2020 and NCF 2023 emphasizes the role of teachers beyond ICT or other advanced technologies like AI in social-emotional learning there exists a gap in creating effective programmes for students' socio-emotional development.

Both the potential and the limitations of technology in education are illuminated in the study. The responses of the questionnaire for collecting perceptions underscore its value, especially in cognitive learning. Although the indispensable role of direct teacher involvement in areas requiring emotional engagement and skill-based learning highlights those responses. These insights emphasize the need for well-structured training programs that not only enhance technological awareness but also guide teachers in adopting a balanced, pedagogically sound approach to technology integration.

Educational Implications and Recommendations for Technology Integration Policy in Indian Classrooms

The findings of the study provide valuable insights into the role of teachers and technology in education, particularly in the Indian context, where the National Education Policy (NEP 2020) and National Curriculum Framework (NCF 2023) emphasize technology-enhanced learning. Based on the analysis, the following educational implications are proposed:

Educational Implications

1. The CASEL framework: The CASEL framework includes five fundamental competencies, namely self-awareness, self-management, social awareness, relationship skills, and responsible decision-making. Self-awareness involves recognizing one's emotions, thoughts, and values and understanding their impact on behaviour. Self-management refers to effectively managing stress, controlling impulses, and motivating oneself. Social awareness entails showing empathy, understanding diverse perspectives, and respecting others. Relationship skills involve maintaining healthy relationships

through effective communication, cooperation, and conflict resolution. Lastly, responsible decision-making involves making ethical, constructive choices about personal and social behaviour (Cavioni, Broli, & Grazzani, 2024).

The CASEL Framework can be included in upcoming educational policy.

2. Strengthening Teacher Training on Technology Integration

- As only 12% of teachers exhibit high awareness of technology and 55.3% have moderate awareness, there exists the need for systematic professional development programmes to elevate the digital literacy of secondary school teachers (Phase I).
- Regular training programmes, workshops, and certification courses should be conducted at the national and state levels to ensure that all teachers are equipped with the necessary skills emphasized in NEP 2020 and NCF 2023.

3. Encouraging Blended Learning Approaches

- In this study, 40 % responses support teacher-technology synergy, and it shows that a combination of teachers and technology is the most effective approach, especially in the cognitive domain. Therefore, policy shifts may be for promoting blended learning.
- The Diksha Platform, NISHTHA training programmes, and SWAYAM MOOCs should be expanded to support teachers in designing hybrid learning experiences.

4. Prioritising human interaction in the affective domain

- Sixty-nine percent teachers emphasized the irreplaceable role of teachers in the affective domain. It showcases that policies should encourage teacher-driven social-emotional learning (SEL) as proposed in NEP 2020, with technology serving only as a supplementary resource.
- Holistic education mentioned in NEP 2020 should be implemented through teacher-led values education, ethical decision-making modules, and classroom discussions.

5. Facilitating Infrastructure for Equitable Access to Technology

- Despite increasing adoption, technological accessibility remains a challenge in many rural and under-resourced schools in India. Therefore, for providing low-cost digital

devices, high-speed internet access, and well-equipped smart classrooms in underserved areas, public-private partnerships should be encouraged.

- To ensure inclusive access to digital education for students and teachers in remote locations, the PM eVIDYA initiative should be expanded.

6. Personalising Technology for Psychomotor Skill Development

- Fifty-eight percent teachers believe hands-on learning is more effective for psychomotor skills, and this finding suggests that technology should not replace human teachers but should assist in skill development. Thus, the policies should support technology integration in skill-based education, such as using Virtual Reality (VR) and Augmented Reality (AR).

- In sports, performing arts, and technical education, AI-driven adaptive learning systems should be promoted to provide real-time feedback on physical movements.

7. Integrating AI Responsibly in Education

- As NCF 2023 highlights AI as an evolving educational tool, policymakers should frame guidelines on AI in education to ensure its ethical use, prevent over-dependence and support teachers in creating AI-assisted lesson plans.

- For ensuring accessibility for all students, AI-driven personalized learning platforms should be customized for Indian languages and diverse learning needs.

8. Promoting Research on Teacher-Technology Synergy

- As the study emphasizes the need to continuously evaluate teachers' perceptions and technological impact on learning outcomes to assess and refine technology integration policies based on empirical evidence, the government should establish dedicated research centres within institutions such as NCERT, NIEPA, and UGC.

References

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* Longman.

Ayeni, O. O., Al Hamad, N. M., Chisom, O. N., Osawaru, B., & Adewusi, O. E. (2024). AI in education: A review of personalized learning and educational technology. *GSC Advanced Research and Reviews, 18* (2), 261-271.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain.* Longmans, Green**.**

Cavioni, V., Broli, L., & Grazzani, I. (2024). Bridging the SEL CASEL framework with European educational policies and assessment approaches. *International Journal of Emotional Education, 16*(1), 6–25. https://doi.org/10.56300/ULTX1565

Chan, C., & Tsi, L. (2023). *The AI revolution in education: Will AI replace or assist teachers in higher education?* arXiv. https://doi.org/10.48550/arXiv.2305.01185

Felix, C. V. (2020). The Role of the Teacher and AI in Education. In E. Sengupta, P. Blessinger & M. Makhanya (Eds.), *International Perspectives on the Role of Technology in Humanizing Higher Education* (Vol. 33, pp. 33–48). Emerald Publishing Limited. https://doi.org/10.1108/S2055-364120200000033003

International Society for Technology in Education. (2003). *Educational technology standards and performance indicators for all teachers*. National Educational Technology Standards for Teachers. Retrieved from the World Wide Web: *cnets.iste.org/teachers/t_standards.html*

Kalyani, D. (2024). The role of technology in education: Enhancing learning outcomes and 21st-century skills. *International Journal of Scientific Research in Modern Science and Technology, 3*(4), 5–10. https://doi.org/10.59828/ijsrmst.v3i4.199

Koeller, M. (2012). From baby boomers to generation Y millennials: Ideas on how professors might structure classes for this media conscious generation. *Journal of Higher Education Theory and Practice, 12*(1), 77.

Kumari, A., & Nigam, S. (2023). Technology integration in education: A catalyst for transforming learning - The new education policy 2020 perspective. *International Journal of Creative Research Thoughts, 11*(9), [page numbers if available]. https://www.ijcrt.org

Mahadevan, P., Thayumanavar, B., Gupta, R. K., Kiruthiga, R., & Nath, D. (2024). Personalized learning paths: Leveraging artificial intelligence and machine learning for student-centered education. *European Economic Letters, 14*(3). http://eelet.org.uk

Manyika, J., Chui, M., Miremadi, M., Bughin, J., George, K., Willmott, P., & Dewhurst, M. (2017). *A future that works: Automation, employment, and productivity*. Chicago: McKinsey Global Institute.

Ministry of Education, Government of India. (2023). *National curriculum framework for school education 2023*. https://ncf.ncert.gov.in

Ministry of Education, Government of India. (2020). *National Education Policy 2020.*

Mohammed P.S., & Watson E. N. (2019). Towards inclusive education in the age of artificial intelligence: perspectives, challenges, and opportunities. In: Knox J., Wang Y., Gallagher M. (eds), *Artificial Intelligence and Inclusive Education. Perspectives on Rethinking and Reforming Education*. Singapore: Springer. https://doi.org/10.1007/978- 981-13-8161-4_2

Nye, B.D. (2015). Intelligent Tutoring Systems by and for the Developing World: a review of trends and approaches for Educational Technology in a Global Context. *International Journal of Artificial Intelligence in Education, 25*(2), pp. 177-203

Pavlik, J. V. (2023). Collaborating With ChatGPT: Considering the Implications of Generative Artificial Intelligence for Journalism and Media Education. *Journalism & Mass Communication Educator*, 107769582211495–. https://doi.org/10.1177/10776958221149577

Pradeep, R. M. M. (2024). *AI meets Bloom: The role of Bloom's taxonomy in an AI-enabled world*. https://doi.org/10.13140/RG.2.2.28275.64804

Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the horizon, 9*(5), 1-6.

Saiz-González, P., Sierra-Díaz, J., Iglesias, D., & Fernandez-Rio, J. (2024). Exploring physical education teachers' willingness and barriers to integrating digital technology in their lessons. *Education and Information Technologies*. https://doi.org/10.1007/s10639-024-13060-9

Sardar, A. (2023, July). Can human teachers be replaced or retained in the AI age?: An overview. *International Journal of Creative Research Thoughts (IJCRT), 11*(7). Retrieved from www.ijcrt.org

Schiff, D. (2021). Out of the laboratory and into the classroom: the future of artificial intelligence in education. *AI & Society, 36*(1), 331–348. https://doi.org/10.1007/s00146-020-01033-8

Tomei, L. A. (Ed.). (2005). *Taxonomy for the technology domain*. IGI Global.