CHAPTER 3

BLENDED PEDAGOGY 4.0: HUMAN TEACHERS AND GENERATİVE AI İN THE CLASSROOM

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Abstract

This paper explores conceptualizing Blended Pedagogy 4.0 as an integrative framework of the generative Artificial Intelligence (AI) and positions human teachers in a corresponding partnership rather than a competitive relationship. The rapid advancement of generative AI is restructuring current educational practices and teaching-learning, thereby challenging a re-examination of traditional & blended pedagogical models. This paper critically examines the growing roles of teachers as facilitators, proper decision makers, mentors, and guides, highlighting the irreplaceable emotional, social, and moral dimensions of teaching that go beyond the algorithmic capabilities. The evolution of Pedagogy 1.0 to Pedagogy 4.0, the study says, is Blended Pedagogy 4.0 as a learner- centred, pedagogical flexibility, adaptive, need-based, co-creative approach grounded in personalization and human judgment. The paper explores AI supported to classroom practices, assessment mechanisms, and feedback model and the importance of AI instruction needs to balance robotics with professional judgment to ensure authenticity and academic integrity. Generative AI is investigated as a pedagogical tool that supports content generation, several assessments, timely feedback, and instructional variation, while operating as a cognitive scaffold rather than a substitute for teachers. The paper critically discussed the ethical, equity, & policy considerations, such as any bias, data privacy, transparency, and the digital divide, with particular attention to teacher accountability in responsible AI use. Rooted in the Indian education scenario, this study aligns the relevance of Blended Pedagogy 4.0 with the NEP-2020 vision, emphasizing its application in multilingual, inclusive, and experiential learning and its ability to integrate Indian Knowledge Systems. The reaved that the identifying key challenges and implications for redefining teacher competencies, future research directions, advocating for a sustainable, ethical, and learned centred human AI partnership in education.

Keywords: *Blended Pedagogy 4.0; Generative Artificial Intelligence, Human AI Collaboration, AI-Enabled Classrooms, Ethical AI in Education.*

Introduction

Pedagogical innovation is of paramount importance in this age of technological development, in which conventional and standardized methods of teaching and learning have proven ineffective in holding learners' attention and catering to their learning needs. Innovative methods of teaching and learning through AI technology have proven effective in promoting learners' engagement and developing skills of critical thinking, creativity, and collaboration, which are of paramount importance in the 21st century (Kong et al., 2024). AI-based teaching and learning methods empower educators in managing administrative tasks and developing their skills (Kapoor et al., 2023). The rapid emergence of Generative Artificial Intelligence (GenAI) has significantly affected higher education (HE) and transformed the processes of teaching, learning, and research (Allison et al., 2025). Generative AI applications have become more deeply embedded in learning contexts and have introduced new possibilities for teaching and learning, although they have also raised significant concerns about academic integrity, ethical evaluation, and information security (Baig & Yadegaridehkordi, 2024; Chan, 2023; Lai & Tu, 2024). The appearance of generative artificial intelligence cannot be divorced from the deep-seated needs of learners within the educational process. If the educational content is related to the vital interests of learners, then generative artificial intelligence will become a hot topic of concern for learners (Rudolph et al., 2024). Within the educational process, the crisis awareness, curiosity, and knowledge thirst of learners are infinitely magnified, and their concern for educational content will continue to increase. As soon as the opposing educational information emerges, the learners will quickly become involved in the discussions and debates on the educational content, displaying common trends and extreme attributes within the educational phenomena (Hunt et al., 2024). The collective emotions were mobilized, and the application of the generative artificial intelligence also displayed the attributes of labeling and stigmatization. With the development of educational content and the continuous enrichment of the applications of generative artificial intelligence, false information continues to emerge, adding tension to educational discussions.

Shift from traditional and blended learning to Blended Pedagogy 4.0

In the fast-changing world. The use of technology along with classroom teaching is the key to enabling learning in students (Woolfitt, 2015). Traditional learning is in-class learning, where the teacher and the learner are face-to-face, as stated (Nortvig et al., 2018). Blended learning, as stated by Garrison & Kanuka (2004), "is the thoughtful integration of classroom face-to-face learning experiences with online learning experiences (Oliver et al., 2005). Blended learning is "the integrated combination of traditional learning with web-based online approaches," where both

types of learning - online and classroom learning are considered. Over the years, the terms used to describe blended learning have also evolved. Traditional learning involves direct instruction in a classroom environment without much reliance on digital technology. Traditional learning has remained the backbone of learning for many centuries, it may not always be appropriate for today's learners, who are increasingly familiar with technology and digital media in their daily lives (Kumari & Murthy, 2024). The traditional learning environment has the use of direct interaction between the teacher and students, which may be essential for discipline and community building among students. However, the one-size-fits-all approach of the traditional method may not be effective in catering to the learning needs of students. Blended Learning (BL) refers to the integration of online and offline learning processes (Sharma, 2010; Kintu, M. J., Zhu, C., & Kagambe, E., 2017; B. 2012). State that BL refers to the combination of online and face-to-face learning models (Andrade & Coutinho, 2017). Blended learning is a pattern shift from the traditional method of learning because it uses technology in the learning process. This is an adaptive and flexible learning approach since it allows students to interact with the content, socialize, and take part in activities both physically and online. The flexibility of blended learning addresses the needs of different learners since it is a student-centered approach to learning (Kumari & Murthy, 2024).

The conventional pedagogical methods have encountered several challenges, especially regarding their ability to meet the changing demands of the educational field. The conventional methods have encountered challenges in ensuring that every learner gets personalized attention, as they have not been very successful in meeting the needs of every learner. This is due to the inability of conventional methods to cater to diverse learners, where some learners have lagged behind, and others have gone too far (Guan et al., 2020; Sistemleri et al., 2021). The conventional pedagogical methods have encountered several challenges, especially regarding technology. Incorporating technology into conventional pedagogical methods is not very successful, as these methods have failed to incorporate technology efficiently. This is due to the inability of conventional methods to keep up with the changing technology, as technology is constantly changing, and conventional methods have become less relevant (Guan et al., 2020). Incorporating technology into conventional pedagogical methods is not very successful, as these methods have failed to incorporate technology efficiently. The conventional pedagogical methods, especially those enabled by technology, have encountered several challenges, especially regarding teacher training programs. The teacher training programs have not been very successful, as conventional pedagogical methods have not been very successful in enabling teachers to incorporate technology into conventional pedagogical methods (Sistemleri et al., 2021).

Rationale for human–AI collaboration in classrooms

Student-teacher collaboration.

Learning partners: The students and teachers will be learning partners, and they will generate knowledge and critically evaluate it based on the knowledge generated by AI. The teachers and students will learn from each other based on the knowledge generated by AI. For instance, they will learn together and critically evaluate the appropriateness of the learning videos and content provided by AI-generated websites (Chinu. et al., 2025).

Navigators and guides: The teachers will be the navigators and guides, and they will ensure that the students critically evaluate and validate the knowledge generated by AI. This is a critical step in the learning process of students with AI (Chinu. et al., 2025).

Responsible Users and Ethical Guides: The teachers encourage the students to be ethical guides in the use of artificial intelligence technology. They work along with the students to ensure that they are being ethical in their use of artificial intelligence technology (Chinu. et al., 2025).

Motivators and Supporters: The teachers give emotional as well as intellectual support to the students. They enhance the motivation levels of the students during the process of learning (Chinu. et al., 2025).

Reflective learning: Reflective Learners: Students analyze themselves by using the feedback from the AI technology to identify areas of improvement. Teachers analyze themselves using AI-generated feedback to assess the effectiveness of their strategies (Chinu. et al., 2025).

Student-AI Collaboration

Information-AI collaboration: Information seekers and reviewers: Students actively seek suggestions from AI, using it to plan and evaluate their learning. AI provides personalised recommendations, which students critically review (Chinu. et al., 2025.

Self-learners and tutors: Students make use of AI in their improvement of learning. AI helps the students in their improvement of learning since it offers them tutoring services (Chinu. et al., 2025).

Researchers and resource providers: Students make use of AI in their review of resources offered by AI, such as articles, images, and videos. Students are able to learn new things and develop their critical thinking skills (Chinu. et al., 2025).

Communicators and language assistants: Students make use of AI in reviewing their communication skills, both in their native and learning languages. AI assists students in enhancing their language skills through translation and vocabulary (Chinu. et al., 2025).

Experimenters and simulators: Students make use of AI in simulating experiments and in critically reviewing situations. AI assists students in simulating situations, enhancing their capacity for recognizing hallucinations and biases (Chinu. et al., 2025).

Teacher-AI Collaboration

Reviewers and facilitators: Teachers assess the interaction between the students and the AI system and try to initiate a discussion on the risks, assumptions, and hallucinations associated with it. This interaction can be a potential opportunity for the students and teachers to develop a better understanding of each other (Chinu. et al., 2025).

Learning designers and enhancers: Teachers attempt to enhance the learning designs through the resources and suggestions provided by the AI system. Such an approach may present an opportunity for the teachers to enhance the learning goals for the students based on their various interests (Chinu. et al., 2025).

Classroom organisers and managers: Teachers use the learning management systems provided by the AI system to organise the classroom activities of the students. Such an approach may create an opportunity to develop a structured learning environment (Chinu. et al., 2025).

Strategists and data analysts: Teachers use the data provided by the AI system to identify the learning trends, strengths, and weaknesses of the students. Such an approach may create an opportunity for the teachers to use the data provided by the AI system (Chinu. et al., 2025).

Conceptualizing Blended Pedagogy 4.0

The change from the 20th to the century is really big. Blended Pedagogy 4.0 is about education. The old way of teaching was like a factory. It was about the teacher. Now Blended Pedagogy 4.0 is different. It is about the students (Mourtzis et al., 2023). We use computers and the internet to learn. This is a change, for Blended Pedagogy 4.0. Pedagogy 1.0 refers to the last century, where the tough and rigid teaching approach was adopted. There was no room for inclusiveness; everyone was treated the same way. the adoption of technology and new teaching approaches has significantly changed the education system. We are now in the era of new and innovative technology such as AI. We have also moved beyond the Pedagogy 3.0 networks. We are now in

the AI-powered world of Pedagogy 4.0 (Rane et al., 2025). This is more than just technology. It challenges the role of human beings in the Age of Information and Knowledge. We are no longer just consumers of information. We are producers of critical thinking, social knowledge, and maker knowledge. We can break down this evolution into six phases. Educators and theorists were challenged by the "Man-Planet conflict" to build a borderless future for education. This future is centered on human beings. It is important to understand the shift from "Industrial Schooling" in the 20th century to "Smart Ecosystems" in 2025. Therefore, we will examine the technology, the pedagogy, and the roles of teachers and learners in each phase.

Evolution of pedagogy: Pedagogy 1.0 to 4.0

The rapid pedagogy evolution that reflects continuous changes in teaching and learning philosophies, influenced by social needs, technological advancement, and the development of students' potentialities (Bakar, 2021). This evolution from pedagogy 1.0 to pedagogy 4.0 shows a shift from teacher-centred to learner-centred and from content transmission to ability development.

Pedagogy 1.0

Students were considered passive learners at this time. Schools saw students as "empty vessels" and filled them with facts. There was almost no space for curiosity or different ideas. Teachers were in charge. They had all the knowledge. They taught us with lectures they made us memorize things. They gave us standard tests. This is what some people (Altemueller, et al., 2017). There was no scope for inclusiveness. Every student learned the same material at the same speed. It did not matter what they liked or how they learned. The assessment system was too rigid and fixed. Written exams measured learning by testing memory of facts. If we talk about the shortcomings and virtues of this era, this system taught reading and math to many people. It also built a shared national identity (Giordano, 2005).

Pedagogy 2.0

Pedagogy 2.0 refers to learner-centred, constructivist approaches, or to socialized or interactive classrooms, and represents a shift from the old way of teaching, where the teacher is in charge, to a greater focus on the learner. Letting them take part in the learning process. This is possible because of the internet and new technology. This is about working together and sharing ideas. The learners are not just listening; they are making things. Sharing them with others. The Pedagogy 2.0 is about letting learners take charge of their learning. They can use things like blogs and online

forums to do this (McLoughlin and Lee, 2008). This is based on the idea that we learn from talking to each other and sharing our ideas. This is called the constructivist paradigm of learning (Vygotsky, 1978). We learn from being connected to people on the internet (Siemens, 2005). This is about thinking and working with others. It is also about learning all your life. These are skills to have when you are using computers and the internet to learn. This is very important for people who want to learn things and be good at using technology. The internet shifted from a site where people viewed information to a site where people could share information. Websites like blogs, wikis, YouTube, and social networks made it possible for anyone to share. Because of this, education had to shift as well.

Pedagogy 3.0

Pedagogy 3.0 was born out of the use of information and communication technology in learning and education. It has allowed for flexible learning through online platforms, Learning Management Systems (LMS), and multimedia tools. It has also allowed students to move from receiving knowledge to creating and sharing it (Matthew et al., 2021). Unlike earlier models of pedagogy, Pedagogy 3.0 has allowed students to become co-creators of knowledge in networked and technology-rich environments. It has allowed students to take charge of their learning and become more creative and independent. Keats and Schmidt (2007) defined Pedagogy 3.0 as open learning systems that facilitate global collaboration, idea generation, and knowledge sharing. This resonates with Siemens (2005), who defined learning as a product of connections among people, networked, and communities. It has also allowed students to make meaning and become lifelong learners. In essence, Pedagogy 3.0 has allowed students to become critical thinkers and innovators, and has prepared them for a knowledge-based and technology-overloaded society.

Blended Pedagogy 4.0

There are various definitions of blended teaching. The overall definition of blended teaching is the comprehensive application of multiple modes of teaching and multiple teaching techniques. It is not only a combination of online and offline learning, but also a combination of multiple learning approaches, such as learning resources, learning media, learning environment, and learning style (Zhang et al., 2022). In some cases, blended teaching and blended learning are used interchangeably and refer to the same thing, and blended teaching and blended learning refer to slightly different things (Bozkurt et al., 2020, 2022a). In most cases, blended teaching is defined as a combination of offline and online teaching, and it has the features of both online and offline teaching so that they are mutually complementary (Elgohary et al., 2022). More and more research has proven the

flexibility of blended learning. For example, in their research, Bozkurt and Sharma (2021) pointed out that "the flexibility of blended teaching is reflected in that blended teaching can achieve full play of the advantages of online teaching and offline teaching, and control the disadvantages, and provide learners, teachers, and institutions with the flexibility of time, space, speed, and path" (Bozkurt et al., 2020).

Defining Blended Pedagogy 4.0

Blended teaching can be roughly divided into the initial stage and the development stage. In the early stages of blended learning, when the concept of blended learning was new, the main focus of blended learning was the combination of face-to-face teaching (traditional teaching) and computer-mediated (online teaching) activities as the main aspect of blended learning. In addition, in 2000, the concept of "blended learning" mainly focused on the characteristics of blended learning. Blended learning offers a better definition of the ratio of online and face-to-face teaching. In addition, in blended learning, there are no limits to the combinations, as mentioned in the study of Park and Doo (2024). In other words, what kind of blended learning will be implemented depends on what is mixed. What's the mix? How many teaching components are mixed and in what order? According to Allen et al. (2007), blended learning can be divided into four types based on the proportions of traditional learning, web-facilitated learning (less than 30%), blended learning (30% to 79%), and most of the online learning (over 80%). In addition, future researchers will often find that the ratio of blended learning in a hybrid course will be 30-70% online teaching. On one hand, blended learning upholds the integrity of traditional learning and promotes the development of online learning, mobile learning, and active learning (Xiang et al., 2022; Moskal et al., 2013). With the development and application of blended learning, researchers have started to explore and define blended learning from the perspective of teaching strategies, teaching methods, and teaching design in the context of blended learning (Min W et al., 2023). Horn and Stolker (2017) proposed four types of blended learning in the context of K-12 education, namely, rotating model, flex model, self-mixing model, and rich virtual model. Education 4.0 is a new vision for education that is driven by technological innovation and the changing needs of the workplace. In Education 4.0, students are expected to develop critical thinking skills, problem-solving skills, and creativity. They also need to be able to adapt to change and learn new things quickly (Van Merriënboer & Kirschner, 2018; Gadicha et al., 2024)

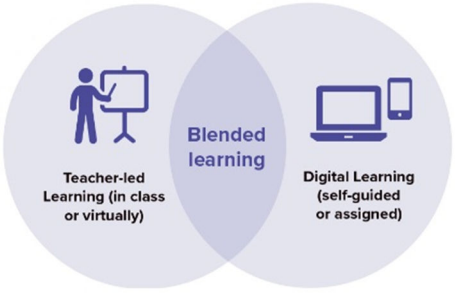

Figure 1. Venn diagram of blended Learning

The implementation of GenAI in education is grounded in several theoretical frameworks, as identified by W. Holmes (2021) and further developed by Slimi Z. Slimi (2023).

- Constructivist Learning Theory - Supporting personalized knowledge construction
- Adaptive Learning Systems - Enabling dynamic content adjustment
- Social Learning Theory - Facilitating collaborative learning environments
- Cognitive Load Theory - Optimizing information presentation
- Technology Acceptance Model - Understanding adoption patterns

Role of Human Teachers in AI-Enabled Classrooms

The various technologies associated with artificial intelligence are changing the nature of the teaching profession by reducing administrative tasks, providing valuable insights, and facilitating professional development. This has enabled teachers to channel their time and energy towards creative and strategic elements of the profession, which enhances the quality of education imparted (Fakhar et al., 2024).

Role of AI as an Assistant for Lesson Planning and Resource Allocation: The role of artificial intelligence technologies becomes significant while discussing the effective planning of lessons and allocation of resources for teachers. Technologies like Scribe Sense and Plan board help teachers plan effective lessons through the application of artificial intelligence tech nologies (Pedro et al., 2019).

These technologies help teachers analyze the curriculum and plan their lessons while suggesting effective strategies for imparting knowledge through multimedia resources catering to different learning objectives. This ensures effective allocation of time and resources for teachers while planning their lessons (Jiménez-García et al., 2024). In addition, artificial intelligence technologies like Classcraft help teachers monitor students' activities through learning analytics and allocate

resources based on the learning gaps for individual students. This enables teachers to allocate their resources dynamically while enhancing their efficiency as effective teachers (Siddiqui et al. 2025).

Automating Grading and Assessment: The use of AI technology has significantly impacted the grading and assessment process, which is considered one of the labor-intensive activities for educators. AI technology, such as Gradescope, uses a machine learning algorithm in the grading of assignments, quizzes, and essays. Not only does it save educators a great deal of time, but it also helps them in individualized instruction (Hamid et al., 2022). For subjective assessments, AI technology that incorporates NLP technology, such as Turnitin's AI grading tool, can grade essays based on grammar, coherence, and strength of arguments presented. AI technology in grading can ensure timely feedback to students, which is considered to be essential to ensure student progress in learning. AI technology in formative assessments can greatly enhance the teaching-learning process since it provides educators an opportunity to conduct real-time quizzes, thus enabling educators to adjust their strategies accordingly (Hamid et al., 2022; Siddiqui et al. 2025).

AI Tools for Continuous Faculty Development: AI tools play an important role in the development of faculty members by providing personalized learning opportunities for educators. For example, Coursera for Educators uses AI technology to offer personalized learning opportunities for educators based on their styles of teaching. In addition, the tools offer faculty members the opportunity to stay updated on the latest developments in the field of teaching by providing updates on the latest trends and innovations in the field (Jiménez-García et al., 2024). Coaching tools like Teach FX use AI technology to offer faculty members useful insights into how they can effectively engage students in class. In addition, the tools offer faculty members the opportunity to stay updated on the latest developments in their respective fields of study through virtual mentoring tools (Hamid et al., 2022; Siddiqui et al. 2025).

The Balance Between Human Teachers and AI Systems: Even though there are different efficiencies and personalizations in the field of education by applying AI technology, it is not possible to replace the empathy, intuition, and comprehension of the teacher. It is imperative to maintain a balance in the utilization of AI technology in the field of education. The main aim of utilizing AI technology in the field of education is to assist the teacher (Jamal, 2023). Thus, the utilization of AI technology in the field of education is not to replace the teacher. In the study conducted by Jiménez-García et al., 2024, it is emphasized that "teachers are considered fundamental in the development of students' emotional intelligence and critical thinking skills, despite the use of AI tools for administrative and data-based tasks." In the study conducted by Huang et al., 2021, it is emphasized that "it is imperative for teachers to acquire skills related to

digital teaching in order to use AI tools and maintain the 'human essence' of teaching." It is imperative to provide training programs to the teachers in utilizing the AI system in such a manner that it does not reflect a negative impact on the teacher-student relationship.

Role of Generative AI as a Pedagogical Tool

AI increases the efficiency of teachers through the automation of time-consuming activities like curriculum alignment, content curation, and assessment mapping. Technologies like Scribe Sense, Knewton, and Microsoft's Copilot apply machine learning and natural language processing to develop flexible and curriculum-aligned teaching plans using vast amounts of instructional content data (Chatterjee & Bhattacharjee, 2020; Holmes et al., 2019). AI can assist teachers in automating routine administrative tasks, including formatting, updating, and storing lesson file management, which can save teachers more time to concentrate on teaching (Luckin et al., 2016; Schildkamp, 2022). precision in instruction is made possible by the role of AI, which can be seen in tools like TeachFX and the AI Lesson Planner, which can provide teachers with analytics to help guide the planning process (Roll & Wylie, 2016; Zhou et al., 2021). The recommendations may not take into consideration contextual factors like classroom environment and student interests. Therefore, AI-based recommendations should be used alongside teachers' judgments. In this regard, teachers' oversight should be viewed as crucial (Dalton & Proctor, 2021; Williamson & Eynon, 2020). Artificial intelligence is also impacting instructional design by allowing for more structured, adaptive, and data-driven instruction. Intelligent systems can help teachers with instructional scaffolding and alignment to models like Bloom's Taxonomy or Webb's Depth of Knowledge to provide cognitively coherent instruction (Holmes et al., 2019; Zawacki-Richter et al., 2019). AI helps in differentiated learning by using student data to make appropriate recommendations. For instance, Content Technologies Inc. and Bakpax are some AI-based platforms that offer dynamic learning alternatives for different learner profiles without the need for teachers to prepare separate plans (Kose & Ozturk, 2022). Using visual analytics in AI can provide instant feedback to detect any gaps, inconsistencies, or information overload in the instructional design. This is similar to agile principles in instructional design (Fischer et al., 2020; Ifenthaler & Yau, 2020). Despite these possibilities of AI in instructional design, researchers emphasize that instructional designers must consider cultural and pedagogical factors that go beyond the capabilities of AI. AI must act as co-designers rather than replacing human designers (Aleven et al., 2018; Chounta & Avouris, 2019). The extent of AI's effect on pedagogy is largely dependent on how teachers view it as an instrument. Majority of them view it as an aid in making processes easier and providing resources aligned to curriculum needs. However, there is an ongoing debate regarding its alignment to

pedagogical needs as presented by AI-generated recommendations (Delgado et al., 2022; Molenaar et al., 2021). For teachers who enjoy sufficient support in terms of training, infrastructure, and flexibility of AI tools, it promotes feelings of confidence, creativity, and interest. However, in other situations characterized by inadequate resources, it becomes overwhelming, particularly in situations where there is dissonance between AI-generated results and teacher judgment (Southgate et al., 2019; Suárez et al., 2023; Blaik-Hourani et al., 2022; Cheng et al., 2021).

Artificial Intelligence (AI) has now been recognized as a game-changer in the field of education, especially in the context of "content generation." The potential of Artificial Intelligence to generate learning and teaching contents such as lesson notes, quizzes, and summaries, among others, within a matter of mere seconds is undeniable (Tang, 2024). Moreover, this is all possible due to the sophisticated "Natural Language Processing" capabilities of Artificial Intelligence. One of the greatest contributions of Artificial Intelligence to this field is its potential to enable "differentiated learning." The traditional classroom setting often finds it difficult to cater to different needs, talents, and learning styles within a single classroom. Artificial Intelligence has the potential to analyze learner information and generate learning contents according to individual needs.

Classroom Practices under Blended Pedagogy 4.0

Blended Pedagogy 4.0 is the combination of conventional methodologies of teaching and the latest digital technologies, especially Artificial Intelligence (AI), to create a unique, flexible, and interactive learning experience for the students (Chene et al., 2020). Blended Pedagogy 4.0 is consistent with the demands of 21st-century learning, which include competency-based learning, critical thinking, and lifelong learning. Artificial Intelligence (AI) is a revolutionary change in the instructional strategies of the classroom, as it enables teachers to adopt a more data-driven, flexible, and student-centered approach to teaching. Artificial Intelligence enables teachers to create a customized learning experience for the students by using the performance and learning patterns of the students to create a unique learning experience for each student. The platforms of Khan Academy and Duolingo are already using AI to create a customized experience for the students. Blended Pedagogy 4.0 helps students collaborate by using both human and artificial intelligence assistance. Facilitating Group Work with the Help of Artificial Intelligence Artificial intelligence helps teachers create groups based on student capabilities. Smart Discussion Platforms Artificial intelligence helps students discuss concepts by providing questions and ensuring all students are heard. Language and Idea Support Artificial intelligence helps students' express ideas clearly. Enhancement of Peer Learning Artificial intelligence helps teachers provide feedback on student collaboration.

Assessment and Feedback in Blended Pedagogy 4.0

The new form of teaching and learning, which has been referred to as Blended Pedagogy 4.0, can be described as the combination of conventional teaching and learning strategies with the latest technological tools, especially Artificial Intelligence (AI). In the new form of learning, different approaches to teaching and learning with the help of AI have been of great importance in the facilitation of learning for all. Another important aspect of Blended Pedagogy 4.0 is collaborative learning with the help of Artificial Intelligence. Artificial Intelligence helps the students to collaborate with one another by creating a balance of the number of students in the class (Pusca, 2024). Artificial Intelligence helps the students to communicate and collaborate with one another by using digital platforms such as Google Classroom and Padlet, in which the students can share ideas and collaborate with one another and discuss the ideas. Artificial Intelligence helps the students to clearly state their ideas, especially for multilingual classes, and provide ideas on how to improve collaborative learning among the students. learning activities can also be improved through the integration of new learning experiences. For example, AI can be used to develop discussion questions for critical thinking and learning. Simulation learning, with the support of PhET Interactive Simulations, can also be used to ensure that the student learns complex learning concepts through experiments and real-life situations. Formative assessments can also be conducted through the use of instant feedback on student quizzes, assignments, and writing activities, helping the student identify areas of strength and weakness. The use of chatbots can also be used to provide learning support for the student outside the classroom. The gamification of learning can also be used to promote learning through activities that adjust to the performance of the student (). All these activities promote learning through engaging and effective learning experiences, where AI is used as an assistant to the teacher (Rufino et al., 2025).

Ethical, Equity, and Policy Considerations

We are experiencing a period of fast development in educational technology, and the irrational use of generative artificial intelligence has become a normal life in the educational field, which is one of the biggest risks in the education sector today (Yao, 2024). Generative artificial intelligence has grown up simultaneously with the education sector, and its irrational use can easily cause complex and diverse educational problems, which are also mixed with various negative information (Bukar et al., 2024). This not only influences the solving of educational problems and the development and speed of educators' governance of educational issues but also threatens the safety of education. Moreover, once a large number of irrational expressions appear on the educational platform and form an educational group phenomenon, they will enhance educational

problems and even become the focus or catalyst of educational events (Daher et al., 2023). Especially in the current era of highly developed information technology, educators, and learners have considered educational platforms as important places for communication and learning. At the initial stage of the outbreak of educational issues, there was a large number of irrational comments concentrated on the platforms, which posed a serious challenge to the resolution and disposal of educational issues. Not only does it affect the quality of communication on educational platforms, but it also disrupts educational order, poses great obstacles to educational development, and damages the credibility of educators (Dwivedi et al., 2023). Therefore, the problem of guiding and regulating the irrational application of generative artificial intelligence in education has become a serious practical problem that urgently needs to be solved (Yao, 2024; Siddiqui et al. 2025).

Indian Classroom Context and NEP-2020 Alignment

The concept of Blended Pedagogy 4.0 is also quite consistent with the vision of the National Education Policy 2020 as it is focusing more on the development of classrooms in India that are flexible and inclusive and also technology-enabled. The concept that is being implemented here is that the blending of the digital technology and the pedagogy has to be done in order to enhance the quality of education in India. The concept of Blended Pedagogy 4.0, as it is being implemented in the classrooms in India, is the blending of traditional pedagogy and AI-based digital technology like DIKSHA and Swayam. This is particularly significant in the classrooms of India because of the diversification of classrooms in India, particularly in the rural and tribal regions of India. The idea is to bridge the gaps in an inclusive manner. Blended Pedagogy, as it is used in the classrooms of India in the vision of NEP-2020, is consistent with the change in the education system of India because there is a shift in the education system of India from rote-based learning to critical thinking, problem-solving, and overall development. One of the important features of the NEP-2020 policy is that it has stressed the importance of the concept of multilingualism, inclusiveness, and experiential learning, which may also be promoted through the application of Blended Pedagogy 4.0. Furthermore, the policy has also stressed the importance of "learning through one's mother tongue/ regional language for better comprehension and learning at the foundational level" (Government of India, 2020). The application of AI tools will also help in the effective implementation of the concept of multilingual education, as it will provide facilities to enable the active participation of the students. Furthermore, the policy has stressed the importance of "learning through assistive technologies to promote inclusive education for the differently abled students," which may also be considered a constructivist learning theory, where the students will

be actively engaged in the learning process to develop the required knowledge for the subject of interest.

Blended Pedagogy 4.0 will definitely provide an opportunity to incorporate Indian Knowledge Systems in the curriculum as suggested in NEP-2020. This is because the NEP has emphasized the need to incorporate India's rich heritage of knowledge in different fields like traditional science, arts, culture, etc., in modern education (Government of India, 2020). Digital media can be effectively used to incorporate Indian Knowledge Systems in an interesting way like stories, etc. For example, concepts like Ayurveda, Yoga, Environmental Studies, Crafts, etc., can be incorporated in school education by using multimedia resources as well as by undertaking projects in the community. This will not only help in preserving cultural heritage but also provide interesting learning experiences to the students. Therefore, it can be said that if aligned with NEP-2020, Blended Pedagogy 4.0 will provide an opportunity to develop an education system that is neither too local nor too global but rather an education system that is suitable for India (Singh et al., 2023; Mandavkar, 2025).

Challenges and Limitations

Although the utilization of Generative Artificial Intelligence in the field of education has tremendous potential for transformation, the utilization of this technology in the field of education is also associated with some challenges and limitations. This has also been noted by Chen et al. (2022), wherein it has been stated that the utilization of GenAI in the field of education is associated with some technical, educational, and ethical aspects that have to be considered. The technical challenges associated with the utilization of GenAI in the field of education can be noted in the aspect that the utilization of this technology in the field of education is associated with the availability of appropriate technical infrastructure. This indicates that the utilization of GenAI in the field of education is associated with the availability of appropriate technical infrastructure and facilities. In some educational institutions, especially in developing nations, the availability of appropriate technical infrastructure and facilities to support the utilization of AI technologies has also been noted to be lacking. In addition, the utilization of GenAI in the field of education is also associated with some technical complexities in the integration of the tools with the Learning Management Systems (LMS) (Belkina et al., 2025). Another limitation is that there is a need for educators to be trained and to have professional development to be adequately prepared to make meaningful use of GenAI tools. Educators are not adequately prepared to make meaningful use of GenAI tools. This could result in ineffective and shallow use of technology. Moreover, educators need to have professional development to be adequately prepared to cope with the

dynamic nature of GenAI tools. Educators also need to be provided with technical support. In addition to that, there is another limitation that is emerging regarding GenAI tools. The limitation is that there is a tendency for educators and students to be over-dependent on GenAI tools. This could result in a lack of critical thinking and creativity. Another limitation is that there is a need for infrastructure and policy limitations to be addressed to enable GenAI tools to be used adequately. Ethical concerns are another critical area of concern, and this is linked to the use of AI in the education sector. The concerns of data privacy, bias, and equity of access are ethical concerns associated with the use of AI in the education sector. The use of data in the AI system can be a critical challenge to the privacy and security of the data, which needs to be well regulated. In addition, the bias of the AI algorithm and the equity of access to the technology can exacerbate the digital divide (Chen et al., 2022).

The arrival of educational phenomena has gradually weakened the "educational tools" of educational platforms. Learners conceal their true identities, express and vent their emotions in an unconstrained state, and even trample on their due learner responsibilities and morals. However, educational platforms lack effective supervision of highly biased and extreme comments and videos, resulting in irresponsible comments and videos repeatedly appearing on hot searches. As a new battlefield for educational phenomena, educational platforms should review their published content. However, due to the large scale and uneven quality of learners, the inadequate regulatory system of education platforms, and the fact that education platforms use this to increase user volume and activity to obtain economic benefits, there are many reasons for the "weak control" of education platforms, which ultimately promotes the proliferation of educational phenomena (Yao, 2024).

Future Directions and Implications

It is also imperative to adopt an outlook for its integration. The future directions should be aimed at redefining teacher competencies, promoting human-AI partnerships, and filling the research gaps for the successful integration of GenAI in the education sector. The implications of GenAI in the Education Sector: One of the implications of the adoption and integration of GenAI in the education sector is the redefinition of teacher competencies. In the changing digital environment, the teacher is not considered an information provider but an information facilitator, information designer, and information mediator. The teacher should develop competencies in AI literacy, data analysis, and digital pedagogy for the successful integration of AI in the teaching-learning process. Mishra & Koehler (2006) argued that the TPACK framework for teachers has emphasized the need to develop the appropriate balance between technological knowledge,

pedagogical knowledge, and content knowledge. However, in the context of GenAI, the TPACK framework should be extended to include the need for teachers to develop an understanding of the ethics of AI, the capacity to evaluate the content generated by AI tools, and the capacity to guide the student in the correct usage of AI tools.

The other major area of development is the way to human-AI partnership in the education field. Instead of replacing the human teacher in this field, Gen AI can assist the teacher in his or her role. The teacher can also provide his or her point of view in this case. The human-AI partnership in this field can be named the "augmented intelligence" concept, as it is possible to use the power of human as well as artificial intelligence in this case to achieve the best results. However, it is also necessary to consider the way to human-AI partnership in terms of the problem of overreliance on AI and human agency in the process of decision-making (Holmes et al., 2019). Apart from this, the gap that has been identified in the further research area has also been identified in the area of GenAI in the field of education. Even though the research that has been done up to now has focused more on the efficiency and applicability of AI tools, the research that has been done on the long-term impact of the application of AI tools on learning outcomes, cognitive, and socio-emotional development is less. In addition to this, further research should also aim to examine the applicability of GenAI tools in the context of the educational setting, particularly in developing nations such as India, in which infrastructure and cultural aspects are taken into consideration. In addition to this, further research should also aim to examine the aspects of transparency, bias, and data, which are considered while implementing AI tools (Zawacki-Richter et al., 2019).

Conclusion

In this ever-changing world of artificial intelligence-based learning and teaching, it has become imperative to again focus on the importance of human teachers as the core catalysts for the process of learning. While cutting-edge technologies such as Generative AI are being created to become important tools for teachers and educators, these tools will not be able to replace the human aspects of learning and teaching, such as empathy, ethics, culture, and inspiring and guiding the learner. Teachers and educators will continue to be indispensable for facilitating critical thinking, learning, and guiding the learner through this complex web of learning and society. The role of teachers is not being replaced, but it is being redefined and reinforced in this new world of intelligent technologies. It is in this regard that Blended Pedagogy 4.0 comes into the picture as a balanced, ethical, and futuristic approach to learning and teaching. This approach to learning and teaching strikes a wonderful balance between the conventional learning and teaching and the

innovative learning and teaching enabled by the AI technologies. This approach to learning and teaching aligns with the values of equity, accountability, and integrity. This approach to learning and teaching also aligns with the visions of learning and teaching that are currently being advocated in the discourses of learning and teaching. Most importantly, this approach to learning and teaching enables the building of a sustainable association between humans and AI in learning and teaching. In conclusion, the future of education is not about the dichotomy of humans and machines; it is about how we can create a harmonious synergy between the two. By positioning the teacher in the center and using AI as a catalyst, Blended Pedagogy 4.0 provides a way to a future that is at the same time technologically advanced, but also human, ethical, and sensitive to the needs of a world that is in a state of change.

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