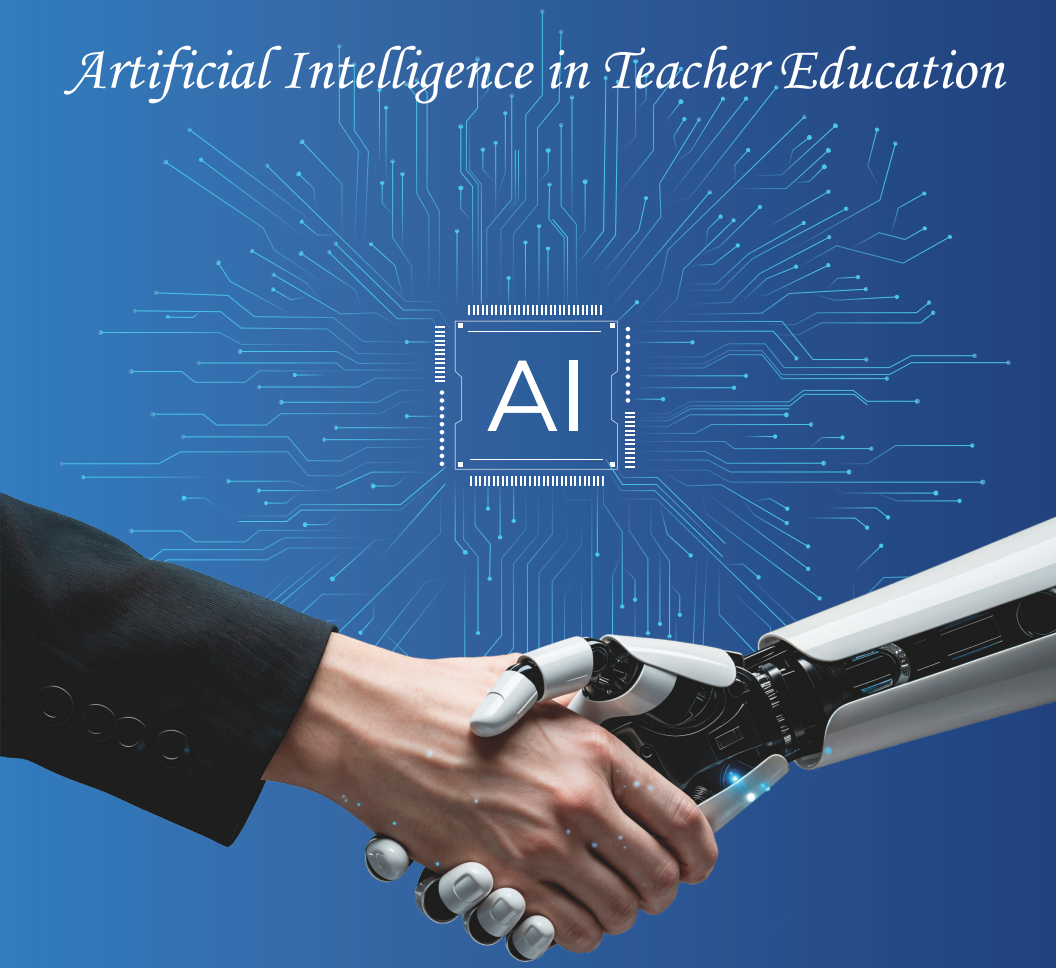
Artificial Intelligence in Teacher Education



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NCTE

समर्थ शिक्षक - सशक्त भारत

National Council for Teacher Education
New Delhi

NEP 2020: Recommendations on AI

"The world is undergoing rapid changes in the knowledge landscape... such as the rise of big data, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines... the need for a skilled workforce... will be increasingly in greater demand... The growing emergence of epidemics and pandemics will also call for collaborative research... There will be a growing demand for humanities and art..." (NEP 2020, p.3)

"Concerted curricular and pedagogical initiatives, including the introduction of contemporary subjects such as Artificial Intelligence…. at relevant stages will be undertaken to develop these various important skills in students at all levels" (para-4.24)

"...numerous upcoming fields and professions that will involve artificial intelligence, machine learning, and data science... Activities involving coding will be introduced in Middle Stage." (para-4.25)

"...the rise of machine learning and Artificial Intelligence (AI)... the nation will require a significant expansion of its research capabilities... Today, the criticality of research is more than ever before for the technological health and progress of a nation..." (para-17.2)

"...India must also take the lead in preparing professionals in cutting-edge areas that are fast gaining prominence, such as Artificial Intelligence (AI), 3-D machining, big data analysis, and machine learning... woven into undergraduate education for enhancing the employability of the youth." (para-20.6)

"India is a global leader in information and communication technology... The Digital India Campaign is helping to transform the entire nation into a digitally empowered society and knowledge economy... technology itself will play an important role in the improvement of educational processes and outcomes; thus, the relationship between technology and education at all levels is bi-directional." (para-23.1)

"New technologies involving artificial intelligence, machine learning... will not just change what students learn in the classroom but how they learn..." (para-23.2)

"...an unquestionably disruptive technology, Artificial Intelligence (AI)... As the cost of AI-based prediction falls... AI will be able to match or outperform... AI's disruptive potential in the workplace is clear, and the education system must be poised to respond quickly..." (para-23.8)

Artificial Intelligence (AI) in Teacher Education

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List of Abbreviations

AI	Artificial Intelligence
AIEd	Artificial Intelligence in Education
AI-EdTE	Artificial Intelligence in Education and Teacher Education
AIGC	AI-Generated Content
AILit	AI Literacy
AI4K12	Artificial Intelligence for K–12 Education
AI@NIE	Artificial Intelligence at National Institute of Education Initiative
AICET	All India Council for Educational Technology
ANRF	Anusandhan National Research Foundation
AR	Augmented Reality
BD	Big Data
BM	Business Model
CAAIE	Centre for Artificial Intelligence in Education
CBSE	Central Board of Secondary Education
CMS	Content Management System
CPD	Continuous Professional Development
CRP	Culturally Responsive Pedagogy
CV	Computer Vision
DEI	Diversity, Equity, and Inclusion
DIKSHA	Digital Infrastructure for Knowledge Sharing
DL	Deep Learning
DM	Data Mining

DPDP Act	Digital Personal Data Protection Act (India)
EdTech	Educational Technology
EDUNET	Education Network (platform/context-specific)
EFL	English as a Foreign Language
ELLs	English Language Learners
EU	European Union
EU AI Act	European Union Artificial Intelligence Act
FL	Flipped Learning
FLN-AXL	Foundational Literacy and Numeracy – Accelerated Learning
GCED	Global Citizenship Education
GenAI	Generative Artificial Intelligence
GDPR	General Data Protection Regulation
GoI	Government of India
GPT-4	Generative Pre-trained Transformer 4
HEAT-AI	Higher Education Act for Artificial Intelligence
HEI	Higher Education Institution
HUMAINT	Human Behaviour and Machine Intelligence
ICT	Information and Communication Technology
INNA	International Network for New AI
Intel	Intel Corporation
IoT	Internet of Things
ITE	Initial Teacher Education
ITEP	Integrated Teacher Education Programme
ITS	Intelligent Tutoring System
JRC	Joint Research Centre (European Commission)
KERIS	Korea Education and Research Information Service
LA	Learning Analytics
LEAF	Learning and Education through Artificial Intelligence Framework
LLaMA-2	Large Language Model Meta AI 2
LLM	Large Language Model
LMS	Learning Management System

MeitY	Ministry of Electronics and Information Technology
ML	Machine Learning
MoE	Ministry of Education
MOOCs	Massive Open Online Courses
NAIRP	National Artificial Intelligence Resource Platform
NCERT	National Council of Educational Research and Training
NCET	National Common Entrance Test
NCTE	National Council for Teacher Education
NDEAR	National Digital Education Architecture
NEP	National Education Policy
NEP 2020	National Education Policy 2020
NISHTHA	National Initiative for School Heads' and Teachers' Holistic Advancement
NITI Aayog	National Institution for Transforming India
NMM	National Mission for Mentoring
NLP	Natural Language Processing
NPCs	Non-Player Characters
NPST	National Professional Standards for Teachers
NRF	National Research Foundation
NSAI	National Strategy for Artificial Intelligence
OECD	Organisation for Economic Co-operation and Development
OCR	Optical Character Recognition
OER	Open Educational Resources
PBL	Project-Based Learning
PL	Personalized Learning
PPPs	Public-Private Partnerships
R&D	Research and Development
RLHF	Reinforcement Learning from Human Feedback
RPA	Robotic Process Automation
SCERT	State Council of Educational Research and Training

SNA	Social Network Analysis
TAS	Teaching and Assessment Strategies
TPACK	Technological Pedagogical Content Knowledge
TPD	Teacher Professional Development
UDL	Universal Design for Learning
UK	United Kingdom
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UTSAV	Unified Teacher Support and Assessment for Value-added Learning
VR	Virtual Reality
WEF	World Economic Forum
XR	Extended Reality
ZPD	Zone of Proximal Development
NDEAR	National Digital Education Architecture

Foreword

The advancement of Artificial Intelligence (AI) is redefining the contours of education globally, opening new frontiers for teaching, learning, and educational governance. In India, this transformation is guided by the National Education Policy (NEP) 2020, which emphasises inclusion, ethics, and pedagogical integrity, and aligns with the nation's vision of *Viksit Bharat 2047*. Central to this shift is teacher education, which must equip educators not only to use technology but to engage with it critically and creatively. This requires a move beyond functional adoption toward reflective, responsible, and context-driven practice.

India's emerging vision for Artificial Intelligence reflects this holistic approach. Initiatives such as the IndiaAI Mission and the IndiaAI Impact Summit 2026 signal a coordinated national effort to harness AI for public good. As Hon'ble Prime Minister Shri Narendra Modi has observed, "*We are entering an era where humans and intelligent systems co-create, co-work and co-evolve*," a powerful articulation of the collaborative future ahead. The imagery of a human and machine working in tandem, as featured in this volume, captures this spirit of partnership, where technology enhances human capability and supports collective progress. India's approach to AI is therefore not merely technological but deeply human-centric, anchored in inclusion, responsibility, and public good.

Building on this national vision, recent initiatives reveal the ways in which it is unfolding across India's educational landscape.

At the Bharat Bodhan AI Conclave 2026, Hon'ble Union Minister for Education, Shri Dharmendra Pradhan, emphasised the systemic integration of AI across India's education ecosystem, supported by the Bharat EduAI Stack- an open and interoperable digital architecture. The establishment of the Bodhan AI Centre of Excellence further strengthens institutional capacity for this transition. Crucially, these deliberations placed teacher capacity building at the centre of the transformation, recognising that the success of AI in education ultimately depends on empowered and future-ready educators.

Amidst these developments, '*Artificial Intelligence (AI) in Teacher Education'* stands out as a timely and forward-looking contribution. The expanding presence of AI offers opportunities to enrich classroom processes, personalise learning experiences, and support evidence-informed decision-making. At the same time, it brings into focus important considerations such as data privacy, algorithmic bias, equitable access, and the role of human judgement in learning, that warrant careful attention. As AI increasingly shapes curriculum design, assessment approaches, and classroom interactions, it encourages educators to reflect on and reimagine established educational practices.

These shifts are redefining the role of teachers, who are called upon to guide learners through increasingly complex and dynamic learning environments. Strengthening teacher preparation to include competencies in AI literacy, critical inquiry, and ethical understanding becomes essential, while reaffirming that the core of education lies in human relationships, values, and purpose. Technology, in this regard, must serve as an enabler, empowering teachers to adapt, innovate, and expand their role, while maintaining the human and pedagogical essence at the centre of education.

Recognising that the integration of AI in teacher education is an ongoing and context-sensitive process, '*Artificial Intelligence (AI) in Teacher Education'* brings together key insights on the role of AI in education and highlights emerging pathways for

integrating AI competencies within teacher preparation. It situates these developments within broader concerns of equity, ethics, and data responsibility, fostering thoughtful engagement rather than prescriptive solutions.

As the national body entrusted with maintaining standards in teacher education, the National Council for Teacher Education reaffirms its commitment to preparing educators for this emerging landscape. By embedding AI within curricula, professional standards, and capacity-building initiatives, it seeks to ensure that teachers are equipped to harness technology in ways that enrich learning, uphold ethical considerations, and expand educational opportunities for all learners.

I would like to express my heartfelt appreciation and gratitude to the members of the Expert Committee – Prof. Ashutosh Bhardwaj, Prof. Ruchir Gupta, Prof. Priya Ranjan, Dr. Subhash Chander, Shri D. K. Chaturvedi, Dr. Waheed Ahmed Ahanger, and Mr. Mukund Jha – for their valuable insights, thoughtful contributions, and dedicated efforts towards the development of this work. Their collective expertise, commitment, and perspectives have significantly enriched the document and contributed to making it a meaningful and forward-looking resource on Artificial Intelligence in Teacher Education. I am confident that it will serve as a valuable resource for policymakers, teacher educators, and practitioners, and will contribute meaningfully to shaping an inclusive, future-ready, and AI-enabled education system in India.

17th August 2026

Professor Pankaj Arora
Chairperson
National Council for Teacher Education (NCTE)

Preface

The integration of Artificial Intelligence (AI) into education marks a significant turning point in how teaching and learning processes are envisioned and implemented. As education systems worldwide adapt to the demands of the 21st century, the role of AI in enabling personalized learning, supporting assessment practices, and enhancing institutional efficiency has become increasingly prominent.

In the Indian context, the National Education Policy (NEP) 2020 provides a clear mandate for leveraging technology to improve access, equity, quality, and accountability in education. Within this broader vision, teacher education occupies a critical space, as teachers are the key agents who will translate technological possibilities into meaningful classroom practices. Preparing teachers to engage with AI is therefore not merely a technical endeavour, but a pedagogical and ethical imperative.

This work, *Artifical Inteligence (AI) in Teacher Education*, represents a collective effort of the committee, shaped through extensive deliberations and rigorous engagement. It is an attempt to develop a comprehensive document that presents a balanced perspective—highlighting the opportunities AI offers, while critically examining its challenges, including issues related to data privacy, algorithmic bias, and the need for human-centered approaches to education. A key focus of this work is to articulate the evolving landscape in education, AI integration in curriculum, future discourse, and the direction of education. It also focuses on

case studies and best practices, the policy landscape for building an ecosystem and proposing recommendations at the end. It also explores pathways for embedding these competencies within teacher education programmes, institutional frameworks, and continuous professional development initiatives. The aim is to support teacher educators and institutions in reimagining their roles in an AI-enabled educational ecosystem.

I express my sincere appreciation to all committee members of the expert group, whose insights and efforts have made this work possible. It is hoped that this work will serve as a guiding resource for stakeholders across the education sector and will contribute to informed decision-making and practices.

(Chair, Expert Group)
Artificial Intelligence (AI) in Teacher Education

Acknowledgement

National Education Policy (NEP) 2020 provides a clear mandate for leveraging technology to improve access, equity, quality, and accountability in education. Within this broader vision, '*Artificial Intelligence (AI) in Teacher Education*' examines the transformative potential of AI while addressing key challenges such as data privacy, algorithmic bias, and the need for human-centered learning. It explores evolving educational landscapes, AI integration in curricula, policy frameworks, and best practices, while offering practical recommendations. The book aims to support teacher educators and institutions in reimagining their roles within an AI-enabled educational ecosystem. I am confident that this publication will make a meaningful contribution toward embedding AI-related competencies in teacher education programmes, strengthening institutional frameworks, and promoting continuous professional development.

I express my gratitude to all seniors and the Drafting Committee members who supported the endeavor of developing & designing this book on '*Artificial Intelligence (AI) in Teacher Education*'. My commendations to the entire team of NCTE.

(Member Secretary)
National Council for Teacher Education (NCTE)

Prologue

Education in India has always been more than the mere transmission of knowledge; it is deeply connected with shaping individuals, communities, and the nation itself. In today's fast-changing and digitally connected world, Artificial Intelligence (AI) is steadily transforming the way teaching and learning are experienced in classrooms and beyond. From government-led initiatives such as the IndiaAI Mission to platforms like DIKSHA, SWAYAM, and PM eVIDYA, there is a growing national effort to make education more accessible, inclusive, and responsive to the needs of every learner.

At the heart of this system are teachers, who remain its greatest strength. In classrooms that are diverse, multilingual, and often resource-constrained, teachers continuously adapt, innovate, and build meaningful connections with learners. In this context, AI is best understood not as a replacement for teachers, but as a support system, one that can help them better understand learners, design engaging experiences, and respond to individual needs with greater sensitivity and effectiveness.

The vision of the National Education Policy (NEP) 2020 aligns strongly with this perspective. It calls for the thoughtful integration of technology while preserving the human essence of education. While tools and methods may evolve, the core purpose of education, grounded in values, critical thinking, and holistic development remains unchanged. To realise this vision, teacher education must also evolve. Institutions such as DIETs, CTEs,

SCERTs, and universities carry a significant responsibility in preparing teachers who are not only technologically competent but also reflective and responsible in their use of such tools.

This book 'Artificial Intelligence (AI) in Teacher Education' is situated within this broader national and educational context. Its purpose is to bring together policy directions, theoretical perspectives, and practical applications of AI, with a particular focus on teacher education in India. The first chapter lays the foundation by situating education within the broader context of global and national transformations driven by Artificial Intelligence. It traces the shift from the pre-AI to the post-AI era, with particular attention to the Indian context, including the role of Indian languages in shaping inclusive digital learning environments. The chapter also reflects on the vision of the National Education Policy (NEP) 2020, especially in relation to AI integration in teacher education and continuous professional development.

The second chapter builds on this foundation by examining the evolving educational landscape at both global and national levels. It presents a trajectory of educational development, moving from ancient traditions to contemporary reforms. Further, it explores the psychological, sociological, and technological motivations for integrating AI into education, while critically engaging with the opportunities and challenges that emerge in this transformation.

The third chapter focuses on the practical dimensions of implementation. It explores curriculum design for both learners and educators, highlighting AI-supported pedagogical approaches to teaching and learning. Special attention is given to addressing the needs of children with disabilities, ensuring inclusivity in AI-enabled education. The chapter also outlines learning pathways, along with approaches to assessment and evaluation in an AI-integrated educational ecosystem.

The fourth chapter turns towards future-oriented discourses and directions in teacher education. It deepens the understanding

of key paradigms such as learning with AI and learning about AI, while also engaging with the emerging competencies and literacies required for educators and learners in an AI-driven world.

The fifth chapter brings together a range of examples, policies, and best practices from both national and international contexts. It critically examines existing frameworks, highlighting their strengths while also identifying gaps that need to be addressed for effective and equitable integration of AI in education.

The sixth chapter presents diverse perspectives and offers a set of well-articulated recommendations. It culminates in the development of a clear and comprehensive AI Teacher Education Framework, designed to guide policy, practice, and capacity-building initiatives.

The final chapter provides a precise conclusion, synthesizing the key ideas and reinforcing the way forward for integrating Artificial Intelligence in teacher education in a meaningful and sustainable manner.

By bringing together theoretical perspectives, policy insights, and classroom realities, this book highlights the significance of adopting a balanced and inclusive approach to AI in teacher education. It emphasizes that technology should serve as an enabler supporting teachers rather than replacing them and contribute to strengthening the overall quality of education.

Introduction

The way we teach and learn is being transformed by artificial intelligence (AI). AI is changing how students find information, how teachers plan their lessons, and how schools measure their own progress. This prolongation puts teacher education at the very foundation of our education system. Preparing teachers for today's classrooms means going beyond basic training in technology. It means helping them build the skills, the confidence, and the ethical understanding to work with AI, not just alongside it (UNESCO, 2023).

India's National Education Policy (NEP) 2020 takes this challenge seriously. It lays out a clear vision for using emerging technologies, from machine learning and data analytics to adaptive learning systems, to strengthen both school education and teacher education (Ministry of Education, 2020). This policy indicates that teachers need to be digitally inclined and capable of utilising AI to create personalised and inclusive learning experiences, moving away from one-size-fits-all assessments. This is not just a minor update; it signals a fundamental change in how we think about teacher development. It pushes teacher education institutions to take a hard look at their curricula, their hands-on training programs, and how they support teachers throughout their careers (Ministry of Education, 2020).

While India must chart its own course with AI in education, there is much to be gained from exploring how other countries are addressing the same challenges. Global organizations such as

UNESCO and the OECD have been confronted with questions about ethics, equity, and what it really signifies for a teacher to be AI-literate in today's classroom. Their work offers India a useful sounding board, a way to check its own assumptions and strategies as bodies like the National Council of Educational Research and Training (NCERT) and National Council for Teacher Education (NCTE) work to build a stronger teacher education system.

1.1. Background: Global transformation of education through AI

The recent proliferation of AI in the education sector is no longer an experimental conviction. It is actively changing the daily reality of how students learn and how schools operate. We are seeing AI move out of the pilot projects and into the mainstream, where it is beginning to reshape the very structure of teaching and administration. This alteration is powered by the coming together of three key trends- the explosion of big data, the growing sophistication of machine learning, and the fact that digital learning platforms are now everywhere (OECD, 2025). Because of this, educators and policymakers are starting to view AI not just as a gadget, but as a practical way to tackle long-standing challenges like improving efficiency, widening access, and making learning more personal. The most significant change is the move away from a standardized, one-size-fits-all model of education toward environments that adapt to the individual. For instance, modern AI-powered systems can now process huge amounts of student data instantly, allowing them to tailor lessons and content to match each learner's specific pace, style, and level of understanding.

Of course, none of this potential means much if we ignore the real-world problems of unequal access, ethical risks, and the digital divide. Looking at how countries like the US, Finland, Japan, and Singapore are rolling out AI gives us a

useful preview. They are showing what is possible when you use these tools to strengthen digital skills and help people adapt in a changing workforce (OECD, 2021; Holmes et al., 2022; Luckin et al., 2023). On a global policy level, the message is clear. Recent reports such as UNESCO's Beijing Consensus and its 2023 Global Education Monitoring Report frame AI beyond technological advancements as a genuine venture to build more inclusive and sustainable education systems. At the same time, they are adamant that we need smart policies to grapple with the tough ethical questions that come with AI's growing influence (UNESCO, 2023).

The education scenarios are being transformed not only by the ongoing use of AI for intelligent tutoring and predictive analytics, but also by the emergent AI tools such as ChatGPT, DALL-E, Perplexity and Gemini have evolved from mere technological demonstrations to being integral parts of daily life at an astonishing pace. What makes them different is their ability to produce sophisticated text, images, and code on demand, which is already forcing a hard re-think of everything from how students write essays to how teachers design assessments (Ivanov et al., 2024; Radanliev, 2024).

The numbers back up this sense of upheaval. Analysts predict the market for AI in education will grow by more than a third every year for the next decade (Al-Emran et al., 2024). But this is not just about companies selling new software. It points to a deeper change in what we want from education itself, a move away from rigid, standardized curricula toward approaches that value a student's ability to think creatively, adapt, and direct their own learning.

How India responds to these global changes depends heavily on its own unique realities. Its enormous population, its development goals, and the ambitious targets it has set for itself. The National Education Policy (NEP) 2020 lays out a bold plan to use digital and AI tools to make the system more equitable and effective (Ministry of Education, 2020). Projects

like the National Digital Education Architecture (NDEAR) and the IndiaAI Mission show that the government is serious about building its own tech capacity for the public good.

But a clear vision does not always translate smoothly into reality on the ground. India's ability to implement these ideas is patchy at best. Progress is slowed by a wide gap in digital infrastructure between cities and villages, institutions that aren't always ready to adapt, and a teaching workforce whose comfort with technology varies enormously from one school to the next. The rapid adoption of AI by India's elite institutions and private edtech companies stands in stark contrast to the reality faced by the public education system. For most government schools and universities, the basic hurdles of reliable internet, accessible devices, and adapting global tools to local languages remain a daily struggle. The problem is compounded by the fact that the world's most advanced AI models (popular ones are shown in Figure 1) are trained on data that is overwhelmingly English.

Consider a teacher in Maharashtra's rural part trying to use a global AI teaching assistant. The tool may recommend instances about snow days or Indian historical figures, and the language it defaults to simply fails to resonate. It is a fundamental mismatch that renders the technology nearly useless in that context. This cultural and linguistic blind spot is the real danger of treating AI as a one-size-fits-all import.

We can not just plug in foreign platforms and adapt upon it by proactively utilising our daily activities. We need AI that understands our linguistic landscape, trained on data that reflects our diversity. It has to be shaped by Indian researchers and developers who are acquainted with the nuances of a Marathi classroom or a Tamil textbook. And above all, we need a governance framework that is not just an afterthought, but a fence that protects our teachers' autonomy and our students' right to an education that speaks their language.

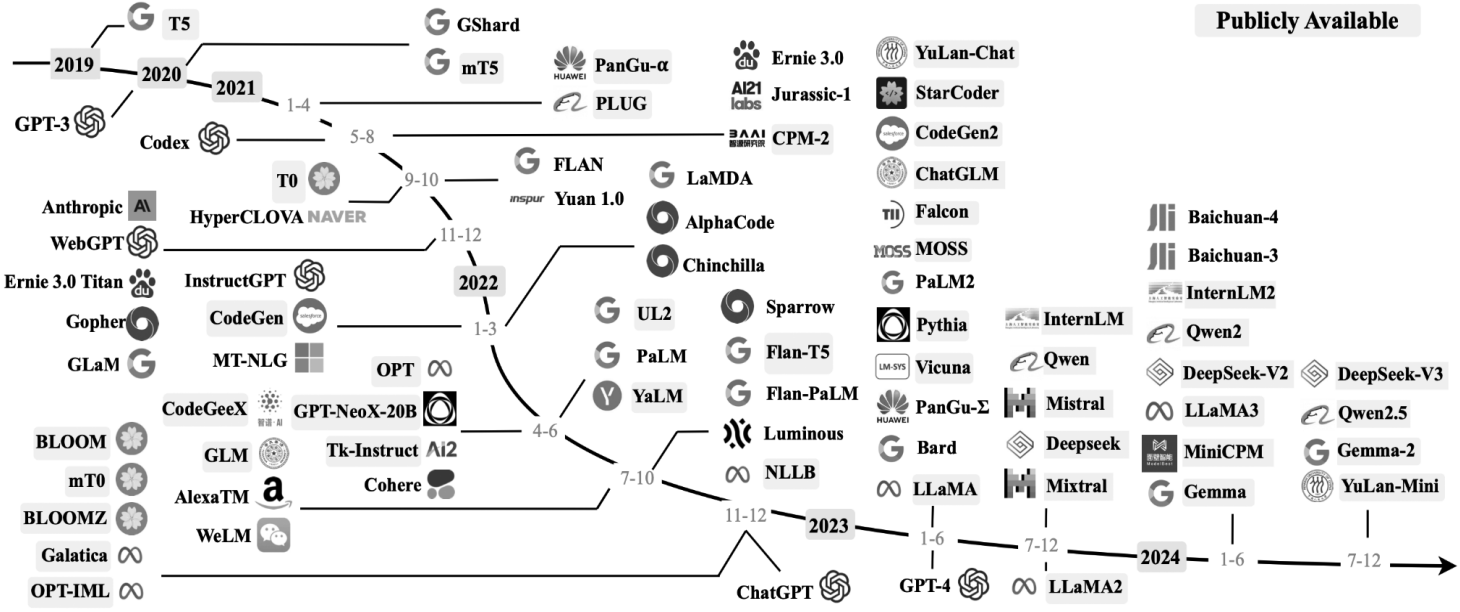


Figure 1: Evolution of Large Language Models

1.2. Digital Technology and Education in India

India's education system is defined by its massive size and cultural variety, which essentially makes the country a global hub for fresh talent and innovation. Technology has not just been an add-on, it has been the primary force behind how the system has grown and changed. This prolongation follows consistent government efforts to integrate digital tools and communication technologies into the daily lives of schools and universities across the country. Schemes from different government bodies have aimed to create positive change, but progress toward truly AI-enabled education has been slowed by persistent, real-world hurdles.

The persistent digital divide in many regions is further compounded by inadequate infrastructure and a shortage of educators equipped with technical skills. Earlier waves of technological change, especially the ICT@Schools initiative, SWAYAM, DIKSHA, and the National Digital Library, made their mark by expanding access to educational content (Ministry of Education, 2020). Their biggest impact was in getting materials out to more people, a trend that peaked during the COVID-19 pandemic when online learning became a lifeline. Today, both learning with technology and learning about it are firmly part of the National Curriculum. However, these early efforts, while successful in widening reach, did not fundamentally shake up the core methods of teaching assessments. The adoption of technology for educational systems does not rely on policy aspects only, but is catalysed decisively by the classroom practitioner. Teachers function as the critical interface between formal mandates and the situated dynamics of teaching and learning. The professional opinion and pedagogical prudence of a teacher eventually form how centrally the underlying reforms are interpreted, adapted, and enacted within diverse instructional contexts.

By navigating this inherent discrepancy between systemic intent and localised application, teachers transform logistical constraints into opportunities for instructional innovation.

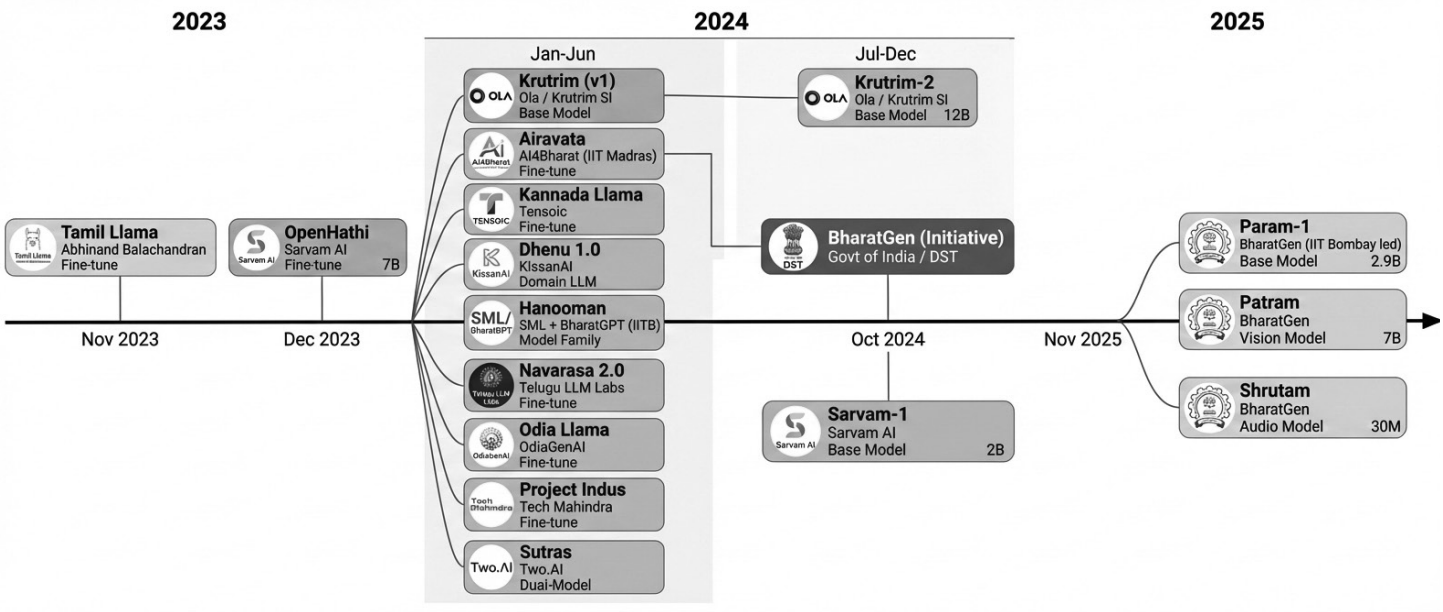


Figure 2: Evolution of Indian Large Language Models

The journey so far has been about first building awareness and access, and now we are finally starting to grapple with the more subtle, difficult task of using ICT to improve how students learn and how teachers teach truly.

The alteration to digital content has given distance learning a significant boost. The Internet in India Report (IAMAI-Kantar, 2023) confirms that the country's digital push has put smartphones and high-speed data connections into the hands of people living in even its most remote corners. While the work of closing the digital divide is far from over, these efforts are already paying off, bringing a wave of new users online and broadening participation like never before.

Now, the rapid ascent of artificial intelligence is shaking things up once again. AI's potential from tailoring lessons to individual students to streamlining school administration is sparking both excitement and intense debate. The National Education Policy (NEP) 2020 acknowledges this shift, outlining a role for AI in education from the school level upwards. The realisation of this vision ameliorates a fundamental re-inspection of teacher preparation frameworks. The central task is no longer merely the cultivation of technical proficiency in new tools, but the development of teachers as informed and AI tools ability to navigate and shape the ongoing pedagogical transformation. This imperative is reflected in the growing body of scholarly inquiry into the applications of artificial intelligence in education, as researchers seek to understand both the affordances and the inherent limitations of these emerging technologies.

The early use of AI in India painted a pretty limited picture. For the most part, it was tucked away in the back end of things handling administrative tasks, running predictive analytics, or powering basic learning management systems. It felt like we were using a supercomputer to do clerical work, treating AI as just another tool for efficiency rather than something that could fundamentally change how we teach (Google Cloud, 2023). But the arrival of generative AI and large language models has

completely changed the game. This is not an extension; it is an entirely new ballgame. In contrast to earlier computational models that operated within strictly predefined parameters (Kanbach et al., 2024), contemporary artificial intelligence demonstrates generative capabilities. These technologies tend to supply emergent outputs including original prose, functional code, visual imagery, and interactive dialogue that latently mimics human communicative patterns (Lim et al., 2023).

This prolongation is already starting to ripple through every level of Indian education from the way lessons are delivered and students are assessed, to how institutions are managed and who gets access to learning. It is no longer a question of if AI will reshape our classrooms, but how we choose to shape its arrival. The current stance of AI models development in the Indian scenario are shown in Figure 2. Classroom enhancements by utilising AI have led to adaptive learning platforms, for instance, it sieves via generated student data, aligning the lesson's pace and content suitable for each learner on the fly (Shoaib et al., 2024). This same notion subscribes to how we assess students, altering the focus from simple rote memorisation toward competency-driven feedback. With its widespread adoption, administrators utilize AI-based dashboards to realise informed decisions on constructs from curriculum design to which teachers may require further support (Budhathoki et al., 2024).On the one hand, AI offers a way to deliver quality education at scale, especially to students in remote areas who have been left out of past reforms. But on the other hand, if we are not careful, it could just as easily widen existing gaps. The reality is that many schools still lack basic infrastructure, teachers have wildly different levels of digital comfort, and the AI models we are using are often trained on data that ignores our linguistic diversity. This signifies a change contiguous for technological progress to the AI-based education system in India. This trajectory will be characterised by complexity and contestation, shaped less by

technological innovation alone and more by prevailing political dynamics and institutional power structures.

1.3. Pre and Post-AI Era with a Focus on Indian Languages

The recent acceleration in artificial intelligence is changing the world, and for a country as linguistically diverse as India, these changes cut deep. Generally, with 19,500 dialects spanning 22 official languages, India has always navigated a complex linguistic landscape, one in which English has dominated the digital sphere (Gunjawate et al., 2021). Now, AI tools like natural language processing and speech to text, often referred to as Bhasha AI are emerging, and they hold the power to either finally bridge this digital-language divide or, if we are not careful, make it even wider.

The biggest hurdle so far has been data. AI models are data-hungry, and while English is rich with it, most Indian languages are not. An accurate interpretation of cultural connotations via AI grounded in a term such as Namaste or to parse the complex grammatical structures of a language like Tamil, training on romanised transliterations or surface-level text is insufficient. What is required are extensive datasets that capture the full spectrum of linguistic nuance, including regional dialects, colloquial expressions, and culturally specific frameworks of meaning. The current absence of such resources for many Indian languages results in a gap. The current set of AI models remain incapable of catering to the very populations where vernacular digital access would be most transformative. This data scarcity effectively renders these communities invisible in the AI-driven digital landscape.

Concurrent with these infrastructural developments, initiatives such as the Bhashini Project, spearheaded by the Government of India, are actively constructing a comprehensive public digital platform dedicated to the nation's linguistic diversity. This platform is instrumental in generating the extensive, high-

quality datasets for training and deploying robust, indigenously developed AI systems. Concurrently, research laboratories within academic institutions and the private technology sector are engaged in the complex task of developing foundational language models tailored specifically for major Indian languages, including Hindi, Bengali, and Tamil.

The prospective outcomes of these converging efforts are profound. For instance, such enhancements could enable the instantaneous and seamless dissemination of policy information, such as a newly announced government scheme originating in Delhi, directly to a Tamil-speaking agriculturalist in a remote part of Tamil Nadu. This would be achieved not through conventional, often imprecise, translation methods, but through an intuitive, AI-driven interface that operates naturally in the user's mother tongue, thereby ensuring comprehensive understanding and fostering greater inclusivity in public engagement.

This is the promise of Bhasha AI for e-governance: moving beyond English and Hindi to deliver information and services directly to citizens, making participation in public life a real possibility for many more people.

The same logic applies to other critical sectors. In healthcare, for instance, NITI Aayog (2018) has pointed out how AI-driven diagnostic tools that can converse in a patient's regional dialect could revolutionise rural medicine, breaking down the communication barrier that often exists between doctors and patients. And beyond governance and health, the commercial and cultural shifts are just as significant. For years, digital content and voice-based services catered largely to English-speaking urban elites. Now, with the rise of AI, we are seeing a rapid expansion of content in languages like Marathi and Punjabi, opening up digital spaces to a massive new audience and creating opportunities for more inclusive economic growth.

For years, the fact that most digital educational content was in English put millions of Indian students at a disadvantage. It created a barrier before learning could even begin. AI is finally offering a

way to tear that barrier down. Imagine a student struggling with a physics concept in a textbook, only to have it explained by an adaptive tutor in their own language, be it Malayalam or Telugu. That is not just translation, it is the difference between memorising words and actually understanding the idea.

But building this future is not simple or risk-free. To make these AI tutors work, you need enormous amounts of data, which immediately raises red flags. One of the biggest challenges is data protection and data privacy. These can be tackled meaningfully to develop future AI systems which are ethically grounded. Further, it is important to train the AI models by selecting the data judicially to avoid biases so that AI tools are just inclusive and should address the students and teachers' needs demographically. The developers should approach cautiously to preserve linguistic diversity by developing AI capabilities to handle major languages as well as tools that should not be resource intensive to cater the needs of disadvantaged sections of society to mitigate digital divide addressing a wider section of society.

Eventually, succeeding in this post-AI era isn't about who builds the most sophisticated technology. It's about whether technology can actually serve people. The real test of success will be if a farmer in Punjab can get reliable weather info in Gurmukhi, or if an artisan in Karnataka can sell their goods globally with the help of a Kannada-speaking AI. Getting there won't be the job of technologists alone. It will require a genuine partnership between computer scientists, linguists, local communities, and policymakers to build systems that are inclusive, ethical, and truly representative of the country they are meant to serve.

1.4. Emerging AI Technologies in Education

1.4.1. Generative AI and Large Language Models

Generative AI garnered quite a traction to traditional educational technology that came before it. Traditional AI systems were

largely limited to tasks like sorting data, making predictions, or following pre-set rules. In contrast, generative AI can create entirely new content essays, images, or computer code by learning from the vast amounts of human-created material it's trained on. Models like GPT-4, DeepSeek-R1, and LLaMA-2 are prime examples. They can produce text and other outputs that feel remarkably natural and context-aware, almost as if you're communicating with another person (Google Cloud, 2023).

In schools and universities, these tools are already being put to work. The integration of generative AI tools into writing instruction can enhance student capabilities by facilitating clearer explanations of complex concepts and supporting personalized tutoring. As Gilson et al. (2023) and Gao et al. (2024) suggest, when these technologies are embedded within a sound pedagogical framework, they have the potential to increase student engagement and cultivate higher-order cognitive skills, including problem-solving and creativity. This suggests that Large Language Models (LLM) are best seen as partners in the learning process, not just as a way to automate tasks. However, the accelerated adoption of such tools has prompted considerable scholarly debate. Central concerns include the potential compromise of academic integrity, the risk of diminishing students' queries via over-reliance on automated outputs, and the menace of fostering only superficial engagement with learning material.

Studies warn that if students lean too heavily on AI-generated answers without questioning or engaging with them, they might fail to truly understand the material or develop their own independent thoughts (Chan, 2023; Lo et al., 2024). These concerns are even more pronounced in a diverse setting like the Indian education system.

The unvarying access to technology given the inherent issue of linguistic diversity, and a firm reliance on exam outcomes supplement the complexity. While LLMs avenue for producing content multilingually and tailoring lessons to local contexts,

realizing that potential depends entirely on careful oversight. It requires clear ethical guidelines and a steadfast focus on actual learning outcomes, ensuring technology serves the educational goal, not the other way around.

1.4.2. Immersive Learning through AI-Driven Virtual and Augmented Reality

Immersive learning technologies, particularly virtual reality (VR) and augmented reality (AR), have gained renewed prominence with the integration of artificial intelligence. AI-driven VR environments enable learners to engage with complex concepts through embodied, experiential simulations, while AR systems overlay contextual digital information onto physical learning environments, thereby enhancing situated cognition and experiential understanding Empirical research demonstrates that immersive learning environments can improve conceptual understanding, motivation, and skill acquisition across domains such as science education, teacher education, medical education, and vocational learning. The integration of AI further enhances these environments by enabling adaptive content sequencing, real-time feedback, and personalised learning pathways based on learner behaviour and interaction patterns.

In the Indian context, AI-enabled immersive learning holds particular promise in addressing persistent resource constraints. Virtual laboratories simulated industrial environments, and historical reconstructions can provide scalable access to experiential learning opportunities in schools and higher education institutions. However, large-scale adoption remains constrained by infrastructural limitations, high implementation costs, and limited teacher capacity. Moreover, ethical considerations related to accessibility, cognitive load, and cultural representation underscore the need for context-sensitive design to ensure that immersive technologies do not exacerbate existing educational inequalities.

1.4.3 The Future of Personalisation: Affective Computing and Explainable Artificial Intelligence (XAI)

Affective computing and Explainable Artificial Intelligence (XAI) represent emerging frontiers in the development of personalised and human-centred educational systems. Affective computing systems seek to identify learners' emotional and motivational states such as engagement, frustration, or anxiety through the analysis of behavioural, interactional, and physiological data, enabling adaptive instructional responses that support learner persistence and motivation (D'Mello & Graesser, 2012).

Complementing this approach, XAI focuses on making AI-driven decisions transparent, interpretable, and accountable. In educational settings, explainability is essential for ensuring that recommendations related to assessment, learner profiling, or content sequencing can be meaningfully understood and evaluated by teachers and learners (Holzinger et al., 2022). XAI thus plays a critical role in preserving human oversight and professional judgment in AI-mediated learning environments.

In the Indian educational landscape, affective computing and XAI offer opportunities to enhance trust, inclusivity, and pedagogical alignment in digital learning systems. Explainability is particularly important in culturally and linguistically diverse contexts, where opaque algorithmic decisions may inadvertently reinforce bias or exclusion. At the same time, the deployment of effective and explainable AI on a scale raises serious concerns related to data privacy, informed consent, and learner surveillance. Addressing these challenges requires robust regulatory frameworks, institutional governance mechanisms, and sustained professional development to ensure that personalised AI systems augment, rather than undermine, the ethical and human dimensions of education.

1.5. National Education Policy (NEP) 2020's Vision for AI in Teacher Education

The National Education Policy (NEP) 2020, is a transformative policy in many senses. It has paved the way for positive transformation in school as well as higher education. The policy addresses technological development in a very balanced way, keeping an eye on future possibilities. It identifies the potential of not just incorporating technology at different levels but also highlights the importance of the transformative use of technology for teaching and learning. It also provides a clear mandate for being prepared with developments related to AI on both fronts.

The policy recognises the importance of curriculum at different levels being future ready. It emphasizes the importance of emergent technologies like coding, AI and computational thinking being introduced to students from a young age. Coding will be introduced in school curricula in a phased manner. Students will be exposed to contemporary subjects such as Artificial Intelligence, Design Thinking, Holistic Health, Organic Living, Global Citizenship Education (GCED), and Environmental Education, at relevant stages *(para 4.24, NEP, 2020)*

"A robust ecosystem of research is perhaps more important than ever with the rapid changes occurring in the world today, e.g., in the realm of climate change, population dynamics and management, biotechnology, an expanding digital marketplace, and the rise of machine learning and artificial intelligence" (para 17.2, NEP, 2020)

The policy has made an important assertion on shifting from memorisation-based learning to competency-based learning that is truly personalised and individualised also. The importance of the use of technology for the same is emphasised in large classroom models.

The NEP, 2020 also emphasises on the importance of establishing robust structures for addressing the development

of technology at different levels and it directly identifies the importance of use of technologies in different systems. *"An autonomous body, the National Educational Technology Forum (NETF), will be created to provide a platform for the free exchange of ideas on the use of technology to enhance learning, assessment, planning, administration, and governance."(para 23.3 NEP, 2020)*

All these points are written with a very critical mention of ethical practices related to use of technology at different places. *"It is also necessary to highlight ethical issues surrounding the development and deployment of AI-based technologies. Education will play a key role in these awareness raising efforts"* (para 23.13, NEP, 2020)

"New technologies involving artificial intelligence, machine learning, block chains, smart boards, handheld computing devices, adaptive computer testing for student development, and other forms of educational software and hardware will not just change what students learn in the classroom but how they learn, and thus these areas and beyond will require extensive research both on the technological as well as educational fronts" (para 23.2, NEP, 2020)

It also highlights the point that the competency development of teachers is also critical for effective use of technology in classrooms. There is a critical need for upskilling the teachers at different levels in the application of digital technology in the classroom. According to NEP 2020 Teachers will be prepared for a shift to technology-enabled and personalized teaching and learning. Pre-service and in-service training will necessarily include modules on the effective and responsible use of technology in the classroom, including AI-based tools.

The role of teachers in integrating technology is critical not just in the classroom but also outside the classroom. Teachers will be the one who would be the main transforming agents in the ground and their understanding of the emerging issues and possibilities is going to determine the success of the policy.

The evolving ecosystem of a variable technological interface in different parts of education in our diverse nation will require a better prepared teacher. Artificial intelligence being the major influence in current times has changed the way the whole world economy as well as education scenario is functioning. New bridges between the use of AI in education are being built very differently and it's changing the way individuals learn. The teachers need to be prepared with the current and future global order as well as with the way people learn. It creates a need for a systemic addressal of understanding related to how AI is influencing education and teachers' readiness.

1.6 Teacher Education and Continuous Professional Development

Teacher education in India has long been marked by concerns regarding quality, relevance, and coherence. Pre-service teacher education programmes are frequently criticised for their theoretical orientation, limited practicum engagement, and insufficient integration of digital pedagogy. In-service professional development, meanwhile, has tended to be episodic, compliance-driven, and weakly connected to teachers' everyday classroom challenges. These structural limitations are exacerbated by large teacher populations, administrative workloads, and restricted opportunities for sustained mentoring and reflective practice (Kumar & Yadav, 2021).

The NEP 2020 explicitly acknowledges these challenges and calls for a comprehensive reimagining of teacher education through multidisciplinary approaches, competency-based frameworks, and continuous professional development (Ministry of Education, 2020). Within this policy context, AI presents significant opportunities to enhance both pre-service and in-service teacher learning. AI-driven platforms can support personalised professional learning pathways, diagnose

pedagogical needs, and provide just-in-time resources aligned with classroom practice (Budhathoki et al., 2024). Generative AI tools, in particular, offer new forms of pedagogical support for teachers. Conversational agents such as ChatGPT and LLaMA2 can assist with lesson planning, content adaptation, assessment design, and reflective practice, while also supporting translation and explanation in multilingual classrooms (Abd-Alrazaq et al., 2023; Ivanov et al., 2024). AI-enabled mentoring systems have the potential to simulate coaching interactions, provide feedback on instructional strategies, and support beginner teachers during induction phases.

Nevertheless, the integration of AI into teacher education raises critical questions about professional autonomy, deskilling, and ethical responsibility. Over-reliance on AI-generated content risks undermining teachers' pedagogical judgement and critical engagement with disciplinary knowledge. Consequently, AI must be positioned as an augmentative rather than substitutive force in teacher education, reinforcing teacher agency, reflective practice, and ethical decision-making in alignment with NEP 2020's vision of empowered professionals.

1.7 Objectives

This document aims to provide a clear and actionable roadmap for integrating AI into India's teacher education system. Our specific objectives are:

1. To map out the current global and national landscape of AI in education, with a sharp focus on what these developments mean for preparing and supporting teachers.
2. To pinpoint the most promising areas for AI integration in teacher education from curriculum design and personalized learning to assessment and administration while honestly assessing the ethical and practical challenges involved.

3. To create a practical, inclusive strategy for building the capacity of teacher education institutions and their faculty to adopt AI tools effectively.
4. To showcase relevant models and best practices from India and around the world where AI is being used successfully in teaching and teacher training, drawing on insights from experts, institutions, and regulators.
5. To offer concrete policy recommendations that can help strengthen digital infrastructure, foster innovation, and make teacher education institutions truly ready for the AI era.

2

Evolving Landscape in Education

2.1 Current global trends and National Context

The emerging trends indicate a paradigm shift in teaching, learning, and managing institutions, particularly due to technological and digitalization advancements. AI is also being used in different domains of education, e.g., individualized learning, administrative automation, and entrepreneurial education (Greenwood, 2025). AI tools, e.g., chatbots, large language models, intelligent tutoring systems, and predictive analytics, are changing the face of education globally.

One major trend is the application of AI for personalized and adaptive learning (HP Online Store, 2024). This is where AI systems analyze the data collected from the students to provide content that is best suited to their learning needs. This is advantageous in the sense that it increases the level of student engagement and also improves the learning outcomes significantly. For example, the application of generative AI tools, such as Chatbots, helps in the creation of content that is best suited to the needs of the students, summarizing content, and also in the learning of the language (Temper et al., 2025). Another major trend is the application of AI in automating the tasks of the teacher, such as grading the work of the students, transcribing the

content of the lectures, and also the creation of quizzes (Lysechko & Petukhova, 2024). The workload is significantly reduced, enabling the teacher to focus more on the pedagogical activities (Thottoli et al., 2024).

In the field of entrepreneurship, AI plays a vital role in the creation of business plans, market analysis, virtual incubators, and the robust support system in the practical skills segment, and the critical role in the development of ethical AI systems, composed of policies and guidelines on the effective implementation of AI, actively promotes the essential principles of transparency, accountability, and fairness in the educational system, thereby assisting aspiring entrepreneurs (Stracke et al., 2024). In addition, the emergence of generative AI in the field of content creation, using LLMs to develop essays, summaries, and learning materials, plays a vital role in boosting creativity in the field of education and providing essential support in the field of learning styles.

In addition, the use of AI in the governance of education and the formulation of education policies is gaining traction. The Higher Education Act for AI (HEAT-AI) framework, which is inspired by the EU AI Act, proposes the risk-based approach in the regulation of the use of AI in education institutions (Temper et al., 2025). The risk levels of the use of AI in education as per EU AI Act are classified into four categories: unacceptable, high, limited, and minimal risk. This indicates the rising concern for the maintenance of academic integrity, data privacy, and inclusivity in the use of AI in education. Furthermore, the focus on the use of AI in education is rising, especially in the context of the importance of AI literacy and education (HP Online Store, 2024). As the use of AI pervades all aspects of life, the need for the education of students and teachers about the ethical issues of the use of AI cannot be overemphasized (Zawacki-Richter et al., 2019).

Programs are also being developed to promote critical thinking and the appropriate use of AI, ensuring that stakeholders

are able to effectively navigate the AI world. However, the adoption of AI in the education sector is not evenly distributed across the world. For instance, developed countries are ahead in AI research and adoption, while developing countries are faced with issues of infrastructure, funding, and digital literacy (Zawacki-Richter et al., 2019). This, therefore, poses a threat of a digital divide in the world, where access to quality AI-enhanced education is not evenly distributed. The solution should focus on bridging the global AI divide, enhancing AI literacy, and developing robust governance frameworks to maximize the benefits of AI in education.

2.1.1 National context: AI in the Indian education ecosystem

Indian education is one of the most diverse systems in the world. The range of diversity in the Indian context does not just emerge from the diversity of the learners, the geography, the socio-cultural milieu, etc. but also from the existence of multiple types of education systems at large. The Indian context cannot be explained without going deeper into diverse contexts. There are institutions having multiple education boards offered to students which facilitate their participation and access. On the other hand, we have primary schools located in extremely difficult terrains with few teachers. The range of lived experiences and contextual needs is equally diverse.

Use of emerging technologies have always been a matter of debate as well as seen as an important catalyst in many ways. Although there is a clarity that technologies are here for facilitating the learners, teachers and the system, there is always an important discussion on how much should be taught at what level to the students. The school curriculum needs to be analysed for the scope of AI implementation at different stages. Also, how AI can be used in education needs to be assessed with the dynamic changes happening in real time.

There is no doubt that global developments and technological advances have created a demand for AI being core to such discussions. AI in the Indian context has spread rapidly with an ease and access of some of its applications being available to all handheld devices. It has brought up excitement as well as ethical concerns at different levels. The whole ecosystem of emerging AI tools are engaging in areas of learning analytics to assessment.

The teacher education curriculum also needs to be seen in the light of integrating the flexibility of emerging technologies within the existing system of education. School education and higher education need to be part of these developments and should have more frequent dialogues for the same.

2.1.2 Educational Development in India: Ancient Foundations and Contemporary Reforms.

Teacher education and Continuous Professional Development (CPD) in India have evolved over millennia, rooted in one of the world's oldest and most sophisticated systems of lifelong learning. Far from informal, ancient Indian practices treated teaching as a sacred lifelong sādhanā (discipline) requiring rigorous preparation, ethical formation, and relentless self-renewal. These ideals continue to resonate in modern policies, especially in the National Education Policy (NEP) 2020, which seeks to restore the dignity of the teaching profession while addressing 21st-century challenges leading to modernity.

Ancient Period (c. 1500 BCE – 1200 CE): Integrated and Lifelong Preparation

The gurukula system and great ancient universities (Takṣaśilā, Nālandā, Vikramaśīla, Valabhi, Kāñchi, etc.) served as the primary sites of teacher education (*Soibam Sheela Devi & Anga Padu, 2024)*.

Key Features

1. Apprenticeship Model: No separate teacher-training colleges existed. Prospective teachers lived as residential students for 12–30 years, mastering Vedas, Vedāngas, philosophy, logic (Nyāya), medicine, statecraft, and arts (Kaibarta, 2018).
2. Learning by Doing: Senior students taught junior ones (monitorial teaching) under the guru's supervision; advanced disciples gradually took full classes.
3. Rigorous Selection & Hierarchy: At universities like Nālandā, teachers (āchāryas, upādhyāyas) were appointed only after public scholarly debates (Śāstrārtha), demonstration lectures, and scholarly council approval. A clear hierarchy existed: Āchārya → Upādhyāya → Sthavira.
4. Built-in CPD Mechanisms:
   A. Śāstrārtha: Equivalent to modern peer review/ conferences
   B. Study tours between centres: Similar to sabbaticals/ exchange programmes
   C. Daily pravacana obligation (teach and learn something new): precursor to mandatory in-service training
   D. Manuscript exchange and royal patronage: Akin to research grants and journal access
5. Philosophical Foundation: Texts such as Taittirīya Upaniṣad, Chhāndogya Upaniṣad, and Buddhist/Jaina canons emphasised tapas (austerity), character, and communication skills (anūcāna-śīla).
6. Women Teachers: Though rare, scholars like Gārgī, Maitreyī, Lopāmudrā, and Buddhist bhikṣuṇīs were recognised authorities.

Teaching was a lifelong vocation of swādhyāya (self-study) and moral exemplariness (Bhatia, n.d.).

तद्विद्धि प्रणिपातेन परिप्रश्नेन सेवया।
उपदेक्ष्यन्ति ते ज्ञानं ज्ञानिनस्तत्त्वदर्शिनः।।
(भगवद गीता से)

You should bow at the feet of your guru, ask questions and learn via serving him. Scholar and naturalist guru will help you with the knowledge of reality.

अनन्तशास्त्रं बहुलाश्च विद्याः, स्वल्पश्च कालो बहवश्च विघ्नाः।
यत्सारभूतं तदुपासितव्यं, हंसो यथा क्षीरमिवाम्बुमिश्रम्।।

There are many books and multiple skills, while time is always short and obstacles are abound. Hence, we should only imbibe the crux of scholarly knowledge like a swan who separates milk from water.

शिष्यादिच्छेत्परां विद्याम्, शिष्यादिच्छेत्सुखं महत्।
शिष्यादिच्छेत्परां कीर्तिं, तस्मात् शिष्यं समाचरेत्

A teacher who expects the highest knowledge, joy of learning, and scholarly fame should respect his pupil and provide righteous guidance.

Post-Independence Period (1947–present): Expansion, Regulation and Reform

At independence, India had only ~700 teacher-training institutions. Rapid expansion followed, accompanied by quality concerns. The landmark commissions and policies that facilitated this expansion have been mentioned below:

Year	Commission/Policy/Report
1948	Tarachand Committee on Higher Education
1948-49	University Education (Radhakrishnan) Commission

1952-53	Secondary Education (Mudaliar) Commission
1956	University Grants Commission (UGC) Act
1964-66	Education (Kothari) Commission
1968	National Policy on Education
1975	National Curriculum Framework
1977-78	Ishwarbhai Patel Committee
1983-85	National Commission on Teachers-I (School Teachers)
1985-86	National Commission on Teachers-II (Higher Education Teachers)
1986	National Policy on Education
1988	National Curriculum Framework
1990-91	Rammurthy Review Committee Report
1991-92	CABE (Janardhana Reddy) Committee Report
1992	Revised Program of Action
1992	Rehabilitation Council of India Act
1993	Yash Pal Committee for School Education (Learning without Burden)
1993	National Council for Teacher Education (NCTE) Act
2000	National Curriculum Framework
2000-01	Sarva Shiksha Abhiyan (SSA)
2005	National Curriculum Framework
2005-09	National Knowledge Commission

2009	Right of Children to Free and Compulsory Education Act
2009	National Curriculum Framework for Teacher Education
2009	Yashpal Committee for Higher Education
2009	Rashtriya Madhyamik Shiksha Abhiyan (RMSA)
2012	Justice Verma Committee Report
2013	Rashtriya Uchchatar Shiksha Abhiyan (RUSA)
2020	New Education Policy
2022	National Curriculum Framework for Foundational Stage
2023	National Curriculum Framework for School Education

Synthesis: Ancient Wisdom Meets Modern Policy
NEP 2020 consciously echoes ancient ideals:

Ancient Concept	Modern Echo in NEP 2020 / Practice
Lifelong swādhyāya	National Professional Standards for Teachers (NPST), Mandatory 50-hour annual CPD
Guru as lifelong learner	National Mission for Mentoring (NMM), Professional learning communities

Apprenticeship & mentoring	Strong practicum, student-teaching, senior teacher mentoring
Śāstrārtha (debate)	Workshops, seminars, online teacher forums
Holistic development	Emphasis on values, life skills, inclusive education
Multidisciplinary knowledge	Teacher education in multidisciplinary universities

Conclusion

India's journey in teacher education reflects a remarkable continuity of vision: the teacher as a lifelong learner, moral guide, and facilitator of holistic growth. While colonial disruption and post-independence massification created challenges of quality and relevance, recent reforms, especially NEP 2020 represent a conscious effort to reclaim the ancient ethos within a modern, equitable, and technology-enabled framework. By integrating the timeless guru-śiṣya ideal with rigorous standards, continuous professional development, and multidisciplinary preparation, India is working to fulfil the ancient insight and the Kothari Commission's modern reminder alike: the destiny of the nation is indeed shaped by its teachers.

2.2 Motivations for using AI in education: Psychological, sociological and technological Aspects

Use of technology in Education is based on the robust pillars of research and theories from the fields of educational psychology, sociology and technology. The pedagogical initiatives and institutional changes are influenced by shifts in the research in these areas. The theoretical grounding from these fields has direct

links with the use of AI in education. There have been a lot of issues, challenges, and possibilities that are discussed in different research related to AI in education (Akgun & Greenhow, 2022, Garzón et al. 2025). Use of AI tools in educational settings is no longer based on speculations; it is now developing to be integrated in the educational context with stronger groundings and correlations with theory and research. There is a need to navigate in the current scenario with the support of a robust theoretical framework from psychology, sociology, and technology.

The psychological basis of the use of technology in education and the use of AI in education stems from the theories of learning and cognition. The earliest theories that directly influence are the theories of behaviorism. The direct references to stimuli and reinforcement in behavioristic theories of likes of Thorndike and Skinner, have direct reference to use of reinforcement learning in AI (Schunk, 1996).

Individual differences and learning of students is a matter of concern from curriculum, pedagogy to assessment and have been discussed extensively based on trait theories of learning to constructivist ideas (Allport, 1937, Vygotsky, 1978) . The relation between intelligence and learning that was shaped by the idea of intelligence is now being rethought.

The rise of AI also forces a fundamental re-evaluation of what it means to be intelligent. Psychologist Howard Gardner, the originator of the theory of multiple intelligences, has publicly acknowledged that AI has him rethinking some of his core ideas. AI is expected to radically transform schools by 2050 (Boles, 2025).

The integration of artificial intelligence in education is built upon a foundation of several key technologies, primarily LLMs which power a new generation of sophisticated educational tools. These technologies are not merely computational tools but are increasingly framed within pedagogical theories that guide their application in learning environments. The technological backbone of modern AI in education consists of LLMs, which are deep

neural network-based models trained on vast amounts of text data, enabling them to understand, generate, and interact in natural language. Their capabilities are central to creating thematic, interactive and personalized learning experiences. In education, LLMs are the engine behind various applications, from intelligent tutoring to automated grading systems. AI-powered Chatbots are applications of LLMs designed to simulate and stimulate human conversation. In language learning, for instance, they provide an exploratory space for students to practice conversation and articulation skills, thereby reducing anxiety, improving fluency and confidence. The use of such bots is often grounded in the Communicative Language Teaching (CLT) approach, which emphasizes interaction as a primary means of learning. AI agents are autonomous systems that leverage LLMs to perform complex tasks. These agents can be broadly categorized into:

- Pedagogical Agents, for instance, act as virtual teaching assistants by managing classroom simulations, curating and recommending learning resources, and offering direct student support through adaptive learning techniques and the detection of conceptual errors.
- Domain-specific Educational Agents, which are trained general-purpose AI models, are highly specialized and focused on a set of relevant corpus of examples (also known as fine-tuned) for particular subjects such as science or language learning. For instance, in a scientific context, such an agent can guide students through complex processes like experimental data interpretation and the formulation of testable hypotheses, thereby providing a tailored, interactive learning experience.

The underlying effectiveness of these agents in authentic educational settings is fundamentally driven by three core interconnected capabilities.

First, *Memory* refers to the agent's ability to retain information from past interactions. It fosters a long-term understanding of a student's individual learning journey and maintains short-term

contextual awareness. It functions to create and continually refine personalized learning pathways.

Second, *Tool Use* denotes the agent's capacity to access and leverage external digital resources. The resources include academic databases, calculation tools, and real-time web information. It enables practical applications like the automation of administrative grading, the on-demand retrieval of relevant knowledge, and the generation of current, contextually appropriate educational materials (Young, 2025).

And third, *Planning* involves the agent's sophisticated ability to deconstruct complex academic topics into a sequence of manageable, logical steps and to devise structured instructional pathways. This allows it to dynamically guide a student through difficult subjects with customised instructional strategies.

Collectively, these capabilities enable AI to transcend the role of a mere information repository, facilitating the creation of truly adaptive, responsive, and personalized learning ecosystems. It can dynamically cater to the unique cognitive and developmental needs of each individual learner.

2.3 Learning and teaching design: Exploring possibilities through AI developments

The rapid evolution of AI has permeated educational landscapes globally, fundamentally reshaping the paradigms of learning and teaching. AI is a force that is re-evaluating the roles of both educators and students. The integration of AI tools necessitates a focus on teacher professional development, instructional design, and the ethical considerations of these technologies, while also balancing AI-mediated instruction with crucial human interaction. AI integration places new demands on teachers requiring a shift in their professional roles and an enhancement of their digital competencies. Foundational AI literacy and instructional planning skills are crucial for educators to maximize the benefits of AI-assisted pedagogy. One study outlines five key dimensions

of generative AI (GenAI), literacy for English as a Foreign Language (EFL) teachers, *GenAI Knowledge, GenAI Use, GenAI Evaluation, GenAI Design, and GenAI Ethics (*Law, 2024), (Wang, Derakhshan, & Ghiasvand, 2025). A study found that teachers' AI competency positively predicted their Technological Pedagogical Content Knowledge (TPACK), which in turn positively predicted their teaching performance. This highlights that professional development should be geared towards a fusion of technological and pedagogical knowledge, not just on the tools themselves. Early-career teachers may be more likely to use AI for tasks like course design and real-time feedback to compensate for their limited experience, while more experienced teachers might intentionally limit AI use, believing AI-free environments promote deeper student interaction and higher-order thinking. This necessitates a trainee-friendly and productive hand-holding AI-training session for all teachers in general and senior teachers in particular.

AI acts as a force multiplier enhancing a teacher's ability to implement evidence-based practices while maintaining instructional quality. A Human-AI hybrid co-design model demonstrates how generative AI can be used within a backward planning framework to create learning objectives, assessments, and activities. This model has been shown to improve the alignment, creativity, and efficiency of lesson planning.

AI's impact extends to both personalized and collaborative learning environments. In higher education, AI tools improve personalized learning and assessments, communication, and scaffolding performance. The concept of scaffolding is central to AI's support for learning, as AI can provide individualized support to help students progress within their Zone of Proximal Development (ZPD) (Cai, Msafiri, & Kangwa, 2025). On the other hand, AI can also facilitate collaborative learning by offering peer-learning opportunities and enhancing learner-content interaction.

A comparative analysis of three distinct scholarly approaches to the integration of AI within educational settings is discussed.

Each approach addresses a different facet of this complex integration, reflecting varied contexts, core objectives, and practical outcomes.

The first approach, termed GenAI Literacy for EFL Teachers, originates from the specific context of EFL education in China. Its primary goal is to establish and validate a measurable framework for what constitutes teacher literacy in Generative AI. This framework is broken down into five key dimensions: Foundational Knowledge of AI, Practical Use, Critical Evaluation, Creative Design of AI-integrated activities, and consideration of Ethics (Zhang, 2024). The central finding is the creation of a reliable assessment tool, which in practice provides a clear roadmap for the professional development of language teachers, helping them systematically build their understanding and application of AI tools in their specific teaching domain.

The second approach, AI competency and TPACK is situated within higher education and investigates the interrelationships between different types of teacher knowledge. It focuses on three core concepts: a teacher's general AI competency, their TPACK, and their overall teaching performance. The study's significant finding is that TPACK acts as a crucial intermediary, merely possessing AI skills does not directly translate to better teaching (Kim, et al., 2021). Instead, a teacher's ability to effectively blend their AI knowledge with pedagogical strategies and subject matter expertise is what ultimately mediates and enhances their performance in the classroom.

Finally, the Human-AI Hybrid Co-Design model offers a more universally adaptable framework, applicable across both school and higher education. Its core focus is not on measuring knowledge or relationships, but on introducing a practical, structured process for collaborative lesson planning between teachers and AI (Dogan, 2025). Utilizing a backward planning framework which starts with defining learning objectives, then designing assessments, and finally crafting instructional activities. This means AI is viewed as a tool that can amplify a teacher's

effort, handling time-consuming tasks like generating ideas or drafting materials. The model's key contribution to practice is offering a concrete guide for leveraging AI's efficiency and capabilities while firmly retaining the essential role of human judgment, empathy, and pedagogical expertise in the instructional design process.

Overall, these three approaches represent a progression from defining foundational knowledge to understanding how that knowledge integrates into professional practice, and finally to implementing a collaborative workflow. They underscore that successful AI integration in education is not about teachers being replaced by technology, but rather about enhancing their professional capabilities. The journey begins with building basic literacy and competency. It is mediated through the sophisticated integration of technological, pedagogical, and content knowledge, and culminates in a synergistic partnership where AI handles scalable tasks, allowing teachers to focus on the irreplaceably human aspects of teaching and learning design.

2.4 Opportunities and Challenges

2.4.1 Cognitive Aspect of AI Tools in Education

The integration of AI into educational environments presents a complex duality of cognitive impacts, comprising significant potential benefits alongside considerable risks that necessitate careful management. AI tools offer the possibility of enhancing cognitive skills through mechanisms such as personalized learning, which tailors educational experiences to individual student needs and can foster deeper understanding.

Additionally, AI can reduce extraneous cognitive load by automating routine administrative tasks, thereby freeing students' mental resources for the development of higher-order thinking skills like analysis and synthesis. While interactive AI applications can increase student engagement and motivation,

which are foundational to effective learning processes, these tools pose substantial challenges to cognitive development, primarily through the risk of undermining critical thinking if students become passive consumers of AI-generated answers rather than active problem-solvers. There is also a concern that over-reliance on generative AI could stifle student creativity and originality, while the phenomenon of AI hallucinations, the generation of plausible but incorrect information, threatens to propagate misconceptions if not critically evaluated.

To effectively harness the benefits while mitigating these risks, future directions must emphasize the development of comprehensive AI literacy for all educational stakeholders, ensuring they can use these tools critically and ethically. This should be coupled with the design of reinforcement learning from human feedback (RLHF) that positions educators' as essential reviewers of AI-generated content (Christiano et. al, 2017). Overall, pedagogical practices must evolve to intentionally prioritize and assess higher-order skills such as critical thinking, creativity, and collaboration that AI cannot replicate, all within a robust ethical and regulatory framework that ensures equitable and responsible implementation.

2.4.2 Impact of AI Tools and Road Ahead

Given our aforementioned discussion, the impact of AI tools on cognitive aspects of education is a complex issue with both significant opportunities and challenges.

This duality is evident across five core cognitive domains. Firstly, regarding critical thinking and problem-solving, AI can function as a beneficial catalyst by presenting complex, simulated scenarios that require analytical reasoning, or by acting as a Socratic tutor that guides students toward discovering solutions through questioning (Bettayeb et al., 2024). However, a significant risk emerges if students develop an over-reliance on AI to provide direct answers, which can atrophy their independent

critical faculties and diminish their capacity to grapple with unstructured problems by themselves.

Secondly, in the realm of creativity and innovation, AI tools offer the potential to serve as dynamic brainstorming partners, helping learners explore diverse creative avenues and overcome initial conceptual blocks. Conversely, the very ease and immediacy of generating text, images, or ideas with AI may disincentivize the deep, often effortful personal engagement required for original thought, potentially leading to a homogenization of outputs where student work reflects the underlying patterns of the AI model rather than individual expression.

Thirdly, the impact on memory and knowledge retention is similarly twofold. Adaptive learning systems powered by AI can significantly strengthen long-term retention by personalizing review schedules and targeting individual knowledge gaps with precision. Yet, the pervasive, on-demand availability of information through AI assistants might reduce the perceived necessity and practice of committing foundational knowledge to memory, which is a cognitive scaffold for more advanced learning.

Fourth, the dimension of motivation and engagement demonstrates how AI's interactivity and gamified elements can create compelling, immersive learning experiences that boost student interest and participation. It should be kept in mind that gains from AI aided learning may saturate with overuse. Nevertheless, this positive impact is contingent on thoughtful design and integration. AI tools that are poorly aligned with curriculum goals or that provide frustrating user experiences can quickly lead to student disengagement and skepticism.

Finally, concerning metacognition, the ability to reflect on and regulate one's own learning processes, AI tutors can provide valuable, immediate feedback on study strategies, helping students develop greater self-awareness. The parallel challenge is that students might become dependent on this external

guidance for direction, hindering the internal development of self-regulation skills and the intrinsic ability to evaluate their own understanding and progress without technological mediation.

The road ahead requires a collaborative effort from educators, developers, and policymakers to create an educational ecosystem where AI serves as a powerful and equitable tool for fostering the cognitive skills necessary for the 21st century.

3

AI Integration in Education

3.1 AI Competencies in Education: Exploring Curriculum Designs

3.1.1 AI Competencies for Learners and Educators

Artificial Intelligence (AI) literacy has become a fundamental skill for learners and educators in recent times. With the increase in use of AI technology, it has become extremely important to understand the concept and usage so that it can facilitate effective teaching and meaningful learning (OECD, 2025). The learners as well as teachers need to be aware about the basic competencies related to AI. The understanding of AI should go beyond the basic usage of popular AI tools.

AI literacy is defined as "a set of competencies that enables individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI, and use AI as a tool online, at home, and in the workplace" (Long and Magerko, 2020; Miao & Cukurova, 2024). It allows us to make conscious decisions that are rooted in its fair, responsible and ethical use. This literacy is even more important to educators who facilitate students in developing these competencies within the curricula. It is an open

discussion to identify the core competencies that one would like to impart at different levels of schooling for the synergistic relation between AI and education. These competencies may range from understanding the basics of AI and machine learning to the ethical use of digital technologies for exploring the key areas of implementation of AI in different fields.

Educators play an important role in cultivating AI literacy by integrating AI tools into their teaching practices. They translate the principles of AI into concrete learning experiences that are adjusted as per the cognitive and developmental levels of their students (Miao & Cukurova, 2024). Due to gaps in the educators' AI competencies, they need to be educated in AI within an ethical framework.

There are global initiatives to work on the basic ideas of what should be included in AI literacy frameworks. These frameworks need to be contextual in nature as there is a need to evolve a framework that works for our learners and society. AI Literacy (AILit) Framework is a comprehensive framework developed by the OECD and European Commission. It outlines skills across four areas: engaging with AI, creating with AI, managing AI's actions, and designing AI solutions (World Economic Forum, 2025). According to this framework, each area includes knowledge of AI's technical basics, skills for critical evaluation and creative teamwork, and attitudes that support ethical understanding and human control. This can be interpreted differently for learners and educators. For learners, this translates to identifying AI-driven tools and applications in their daily lives. They may also utilize AI in problem-solving and creative tasks. Learners should recognize societal impacts of AI, including privacy and fairness issues (Stolpe & Hallström, 2024).

For educators, AI literacy includes mastering foundational concepts of AI so that they can confidently integrate it into their teaching. It also includes the skills to design curriculum units that incorporate AI aligned with educational goals. They must develop the ability to foster critical and ethical reflection on AI use among

students. Finally, they must acquire proficiency in recognizing age-appropriate AI resources and responsible AI incorporation in classrooms (Dilek et al., 2025).

One of the primary requirements in moving toward AI literacy is the dynamic nature of AI technologies with continuous development that is evolving exponentially. This requires both teachers and students to learn continuously and be flexible (Miao & Cukurova, 2024). Additionally, there are disproportionate levels of digital access and uneven levels of teacher preparedness. More understanding and clarity are needed for developmental processes to build AI literacy over time across all spheres of society. This could begin with basic concepts in elementary school and move towards more technical topics in secondary school (Yim, 2024). Including AI literacy in various subject areas as opposed to siloed in separate computer science classes can help mitigate inequities and misinformation in a relevant and meaningful way. It supports students' understanding of the kind of role that AI plays in language arts, social studies, and science (World Economic Forum, 2025). The subject based integration will help the disciplinary learning of the students. The NEP 2020 has focused on an interdisciplinary approach to teaching going beyond the discipline centric education in schools. These interlinkages need to be addressed at different levels and AI tools can be used for planning and implementation of interdisciplinary teaching.

3.1.2 Integrating AI Concepts into Existing Curricula

The integration of AI into existing school education curricula is becoming a priority, in the backdrop of the National Education Policy (2020), driven by the transformative role of AI in society. As both professional and personal areas evolve due to AI, curricula need to change to provide learners with the basic knowledge, skills, and ethical understanding required for the 21st

century. AI literacy should be incorporated into various subject areas, rather than being siloed in separate computer science classes, which can help mitigate inequities and misinformation in a relevant and meaningful way. This method makes the content relevant, places AI in familiar contexts, and develops broad skills among diverse learners (Miao & Cukurova, 2024). The integration of AI into various subjects enables students to understand the widespread impact of AI and its effects in different areas, including language learning, science, social studies, and the arts. Additionally, integrating it into the curriculum resolves the issue of limited teaching time. This approach will also avoid overloading pupils with material and utilise pre-existing educational frameworks (Casal-Otero et al., 2023). Finally, it encourages multidisciplinary education. This enables the student to consider the cultural, ethical, social, as well as technical impacts of AI (Touretzky et al., 2019).

Educational structures, such as AI4K12 in the United States, enable schools to incorporate AI concepts into their curriculum. AI4K12 recognises "Five Big Ideas" of significance to the study of AI: perception, representation and reasoning, learning, natural interaction and social impact (Touretzky et al., 2019). They complement current curricula at different grade levels. For example, in science courses, students can learn about how AI employs sensors and machine vision to interpret data. In social studies, students may discuss the social and ethical aspects of AI (Neendoor, 2024). A second important approach is identifying curriculum "entry points" where AI exists organically with current learning goals (Neendoor, 2024). For instance, in mathematics, AI-related topics like machine learning provide authentic contexts for statistics and probability education. In languages, chatbots and translation applications are excellent examples of how communication is enriched with AI through language learning activities. This method enables teachers to expand students' exposure to AI without modifying existing curriculum objectives. Implementing AI in curricula is a sequence

of well-planned steps. The first step is professional development for teachers. This provides educators with basic AI knowledge and teaching strategies for integration. AI experts can help curriculum teams develop AI content that aligns with standards and meets student needs. They can also co-design engaging lessons that include AI. This should be followed by a review and update of curricula to explicitly include AI concepts in core subjects. This may require adding AI learning goals, revising textbooks, and including AI-related projects or labs (Neendoor, 2024). Lastly, the use of AI-powered educational technologies in classrooms supports seamless integration.

Adaptive learning platforms, ITS, and AI content creation tools can personalize student learning experiences and demonstrate AI application. This can help in making complex ideas easier to grasp (Wang et al., 2024). The data analytics features of AI can also help improve the curriculum based on student engagement and performance. Governments and educational institutions worldwide are increasingly supporting the use of AI. For example, China and South Korea have incorporated AI topics into middle and high school programs, focusing on both technical skills and the societal impact of AI (Lee & Kwon, 2024; Knox, 2020). The Central Board of Secondary Education in our country has initiated AI education programs in secondary schools to raise awareness and develop skills from an early age (CBSE, 2019). These efforts reflect a sound understanding that including AI education in the curriculum is essential for preparing students for the future. It will be essential to determine how AI is integrated across different classes so that it is integrated seamlessly in the curriculum at later stages.

The teacher education curriculum also needs to be changed in sync with the developments related to AI at different levels. Both learning about AI-related subjects and preparing for its application are one thing, but being prepared to utilise AI in various aspects of learning is another. Curriculum reshaping should not be limited to introducing a separate pedagogy course,

but also should address the challenges and opportunities related to integrating AI in various areas.

3.1.3 AI Competencies Across Schooling

Research indicates that systematic AI skill development can enhance critical thinking, applied knowledge, and information literacy, particularly when students adopt a constructive approach to generative AI tools (Pallant et al., 2025). If students utilise AI to enhance their knowledge and generate new ideas, rather than merely replicating information, their ability to learn in a practical, integrated, and self-directed manner will increase significantly. Therefore, curricula should embed exploration, hands-on experimentation, and thoughtful evaluation with AI.

Due to the rapid advancement in AI, it is necessary to rethink the foundational skills required of learners. A suitable AI framework must address the needs and build upon the competencies, including problem-solving and computational thinking (Yim, 2024). This will enable them not only to learn how to use AI but also to engage with it in real-world contexts.

At the primary level of education, the focus could be on introducing AI concepts in a manner that arouses natural curiosity, like using AI-aided storytelling. The focus on the knowledge aspect should encompass both theoretical and practical components, including definitions, types, problem-solving, reasoning, data analysis, and real-world applications. This approach introduces students to the diversity of AI in engaging ways, weaving foundational skills across both technical and social dimensions. Secondary schooling can build on these fundamentals by introducing computational thinking, including abstraction, decomposition, and reasoning, along with exposure to machine learning concepts and the ethical issues surrounding data use and bias (Yim, 2024). The ability to think critically and understand abstract concepts in secondary school needs to be addressed through the

development of technology. Additionally, it is the ideal time to incorporate content related to AI to nurture these competencies among learners. Apart from the content, the learning methods should also be in sync to nurture these competencies. Project-Based Learning (PBL) can emerge as an effective strategy in schools to nurture 21st-century skills. PBL will enable students to develop solutions for real-world problems with the aid of AI platforms. For example, they might train simple neural networks or build chatbots that answer questions about historical events (Kong et al., 2024). These experiences help learners link technical knowledge with real-world application and foster a deeper understanding.

Apart from developing skills and knowledge, there is a need to nurture the attitudes of learners and embed ethical issues in the curriculum at various stages. The UNESCO and OECD frameworks emphasise the need to combine ethical and social-emotional learning with technical instruction. This approach prepares well-rounded, responsible AI citizens (UNESCO, 2024). Teachers need to be prepared with the pedagogy of developing the knowledge, skills, and attitudes of learners in schools.

3.2 AI Competencies in Education: Developing AI-based Pedagogy

3.2.1 AI-Supported Teaching-Learning Methods

Artificial Intelligence (AI) is reshaping teaching and learning processes. It is equipping teachers with new ways to improve teaching practices that drive student engagement and performance. To create rich, resilient classrooms that are responsive to the diverse needs of students, AI technologies empower teachers with effective tools to automate administrative tasks, adapt learning, and gain actionable insights (Wang et al., 2024). Artificial intelligence (AI)-powered teaching-learning practice can increase

learning and teaching efficiency by reengineering traditional, rigid approaches into personalized, inclusive, effective teaching practices (U.S. Department of Education, 2023). Personalized learning is the most groundbreaking AI-driven initiative. Personalized learning enables AI systems to alter the pace and design of instruction appropriate for all students, considering their interests, challenges, and strengths.

There are possibilities to utilise real-time data analytics to dynamically rearrange classes, support training, and provide immediate feedback based on students' performance. Allowing students to learn at their own pace is a possibility for achieving mastery and closing learning gaps, thereby enhancing student confidence and motivation (Wang et al., 2024). Additionally, AI is capable of mimicking personal tutoring through making personalized suggestions for assistance and splitting difficult content with AI-based intelligent tutoring systems (ITS) (Kestin et al., 2025). ITS captures student responses to foster comprehension and retention, detect misconceptions, and provide alternative instruction or useful suggestions. Such AI-based tools provide an opportunity for scalable solutions, as well as pedagogical choices, in classrooms with various learner abilities. Through gamification, simulation, and interactive virtual spaces that respond to student behaviour, AI also facilitates learning engagement. By monitoring behaviour and reinforcing good participation, many methods gamify class management, which serves as a motivator and facilitator of group learning (Bovermann & Bastiaens, 2019). Artificial intelligence-based learning games and virtual reality spaces provide engaging and interactive environments that promote active participation with content, enhancing deep learning and critical thinking capabilities (Farahani & Ghasmi, 2024). Furthermore, chatbots and AI virtual assistants provide prompt responses and relevant support outside regular classroom hours. These AI tools can answer questions, help students complete tasks, and promote independent learning. They provide extra instructional support and improve

accessibility, particularly in large or underfunded classrooms (U.S. Department of Education, 2023).

AI systems generate detailed learning analytics and dashboards that enable teachers to track student progress and identify learning patterns in depth (Wang et al., 2024). These learning analytics can be crucial for gaining a deeper understanding of the learner and advancing their learning. This allows educators to offer timely support or enrichment. This data-intensive method enhances formative assessment strategies and supports evidence-based teaching plans tailored to student needs (Farahani & Ghasmi, 2024). AI applications can also take over routine administrative and grading tasks. Automated grading tools, especially for objective assessments, allow teachers to complete their tasks more efficiently. This efficiency lets educators concentrate more on personalised instruction, mentoring, and encouraging higher-order thinking.

AI-powered assistive technologies play a crucial role in inclusive education. They support diversity in the classroom as well as learners with disadvantages, including learners with disabilities. Speech-to-text software, AI-driven captioning, and text simplification tools improve accessibility for students with hearing impairments, dyslexia, or language learning challenges. AI-based real-time translation helps non-native speakers by breaking down language barriers and aiding understanding in multilingual classrooms (Farahani & Ghasmi, 2024). Innovative AI teaching methods also focus on collaboration. They allow students to use AI tools to support group inquiry, creativity, and problem-solving. AI systems assist with group projects by analyzing interaction trends to suggest ways for each person to contribute and providing information about how the team was working together (Siddiqui, 2024). Additionally, AI-based simulations present complex problems that require critical thinking and decision-making. These simulations allow students to apply their learning to real-world applications (Wang et al., 2024).

AI has an important role in planning and development of instructional design for teaching methods that are more inclusive, effective, and aligned with the contextualized learning pathways of individuals. Curriculum development and adoption are one of the important contributions of AI, and it can be used for developing the content more in sync with the learners. Learning outcomes should be aligned with the learner as well as the content with the help of AI tools. Unit planning and lesson planning can be integrated with AI by contextualising it as well as giving scope for performance analysis and feedback opportunities to be integrated at appropriate places.

AI also assists in Culturally Responsive Pedagogy (CRP) by assisting teachers in creating lesson plans that incorporate students' unique cultural backgrounds and experiences, making learning more relevant and engaging. AI tools also provide pathways to universal design for learning (UDL)- based classroom plans through flexible learning options, such as text-to-speech or alternative formats, enabling all students to access and interact with content in ways that best suit their needs and abilities. This personalization helps reduce learning barriers, ensuring a more inclusive and equitable educational experience for everyone.

3.2.2 Fostering Creativity, Critical Thinking and Problem-Solving

There are numerous opportunities to foster creativity, critical thinking, and problem-solving skills through the use of artificial intelligence (AI) applications in the classroom. These three essential abilities are crucial for students' success in today's fast-paced, technology-driven twenty-first-century world (Maurya & Pandey, 2025).

Creativity is fostered when students can quickly iterate on ideas, evaluate others' viewpoints, and receive real-time feedback. AI-based platforms can offer students opportunities

to express their learning and share it with others. Opportunities to co-create and ideate with AI tools should be encouraged. For example, students can engage in creative mathematical thinking by utilizing AI-enabled mathematical modelling software, which also offers multiple techniques to help address the problem (Göktepe Körpeoğlu et al., 2025).

Critical thinking involves questioning assumptions, verifying facts, and considering alternative perspectives. AI can facilitate a critical-thinking mindset by making knowledge available to the students anywhere, worldwide, and by alerting them to possible biases or alternate explanations. Students can then defend their positions, refute information presented by AI, and assess the validity, ethics, and utility of knowledge generated by AI text (The University of Rhode Island, 2024). This will sharpen their skills in evaluation and digital citizenship (Maurya & Pandey, 2025). The feedback loops can help students remain persistent and adjust their approaches even when comprehension is challenging, thereby building resilience.

3.2.3 Nurturing Collaboration and Communication

Collaboration and sharing of ideas have been of utmost importance in current learning environments for teachers and students. AI technology is being harnessed to enable new modes of communication, the exchange of ideas, cooperation, and collaboration, allowing for the co-construction of knowledge in ways that previous classrooms could not (Tan et al., 2024). These are vital skills for student scholarship and professional success. AI-powered learning systems have revolutionized peer engagement and group assignments. They also track engagement to further promote collaboration. AI-integrated Learning Management Systems (LMS) can be used to promote collaboration in various ways through team projects, facilitating the creation and execution of group tasks. Utilizing AI capabilities

such as auto transcription and auto summarisation also enhances group productivity. They not only eliminate communication gaps but also empower each member to make effective contributions. Emerging research argues that students learning in AI environments learn more intensely and communicate more effectively than those in conventional environments (Wang et al., 2024). This approach promotes social learning, which is both beneficial and effective (Kehinde-Awoyele et al., 2024). AI tools significantly enhance communication skills, particularly in multilingual and multicultural settings. Chatbots, virtual tutors, and conversational AI instantaneously offer personalised feedback. This gives pupils immediate guidance while they practise speaking, writing, and listening (Agrawal et al., 2024). For instance, artificial intelligence-powered writing tools support the ongoing improvement of academic writing. At the same time, speech recognition technology aids in accent correction and the development of oral language skills (Doghonadze, 2024). According to a recent study, 30% of educators valued AI for communication-related tasks and acknowledged that these methods promote in-depth and participatory language acquisition (Doghonadze & Kintsurashvili, 2024). AI-powered translation and captioning tools also improve accessibility. This ensures that students from diverse backgrounds and with varying abilities can fully participate in group discussions (U.S. Department of Education, 2023). Adaptive learning systems measure the progress of each individual's learning and change group roles accordingly. This ensures all students can join based on their strong points while also growing their abilities (Kovari, 2025). AI further assists with feedback and evaluation for team projects by allowing teachers to monitor contributions and support various educational goals. For students who have disabilities or struggle with language, tools powered by AI can make communication easier, aid in understanding, and provide tailored answers. This assistance increases teamwork and ensures everyone is involved.

3.3 AI for Inclusive and Equitable Learning

3.3.1 Addressing challenges among learners with disabilities

Artificial Intelligence (AI) has become a crucial tool for implementing inclusive education and addressing the challenges faced by learners with disabilities, while also promoting fairness and social justice through the provision of innovative assistive technologies, personalised learning paths, and adaptive assessment systems. Advanced speech recognition and text-to-speech technologies have improved accessibility for students with visual or hearing impairments. AI-based optical character recognition (OCR) and Braille displays enable individuals with disabilities to access both printed and digital materials independently, thereby closing the gap between physical limitations and educational opportunities (Fitas, 2023).

Studies have shown that AI communication tools can aid students with speech, language, and neurodevelopmental disorders. Social robots are being used to teach social and communication skills to students on the autism spectrum. These robots adapt their interaction style to suit each student's individual pace and preferences, fostering involvement in a safe, judgment-free environment. A major advantage of AI in inclusive education is the opportunity to customize learning. AI platforms can assess how each student learns and what they need, and consequently, modify the content, speed of delivery, and academic assistance (Gupta & Kaul, 2024; Zhao et al., 2025). Students with learning issues, such as dyslexia, may be identified early using AI, and assistance through AI platforms can also be utilised to address these challenges. These platforms use tracking data to identify problems early on. A review by Paglialunga and Melogno (2025) demonstrates that AI methods, such as intelligent tutoring and game-based learning, yield promising results for students with dyslexia and other learning differences. These systems constantly

adjust teaching methods, content difficulty, and feedback to match students' improving skills, enhancing their understanding, speed, and confidence (Paglialunga & Melogno, 2025).

A main goal in inclusive education is to improve student involvement and independence. AI helps students by creating learning environments that utilise sight, hearing, and touch, offering options for diverse needs (Fitas, 2023). Classroom systems utilise learning information to identify students who require additional support and guidance on adjustments, such as modified assignments or peer assistance. These systems enable teachers to create flexible teaching plans that cater to diverse needs. Using AI learning data also enables the evaluation of inclusive actions on a large scale, facilitating rule development and teacher growth (Gupta & Kaul, 2024).

They require training in how to utilise AI tools, the best practices for inclusive teaching, data analysis, and protecting student choice and respect (Gupta & Kaul, 2024). The future of AI in inclusive education looks promising due to ongoing research efforts to improve tools, address access, ethics, and teacher readiness. All teachers need training to utilise AI tools for students with disabilities, learn the best ways to teach inclusively, and protect students' choices and respect (Gupta & Kaul, 2024).

3.3.2 Support for English Language Learners and Non-Native Speakers

Artificial Intelligence (AI) is changing language education. It provides personalized solutions and support for English Language Learners (ELLs) and non-native speakers. AI tools address issues of linguistic diversity, access, and individual learning, helping students overcome challenges to language mastery and academic success (Crompton, 2024).

AI facilitates adaptive language learning that accommodates the unique capabilities and learning speeds of every student. There are platforms that can modify the difficulty level of the

content and create personalised learning pathways according to the learner's efficiency.

It also accommodates individualized instruction required for non-native speakers with diverse educational backgrounds. Studies reveal that language applications powered by AI enhance reading skills, grammar, and speaking abilities more effectively than the standard curriculum. Participants in a study progressed further in speaking and grammar because Babbel offers customized lessons based on individual study patterns and outcomes, validating the advantage of the flexibility of AI for ELLs (Peña-Acuña & Fernandes Durão, 2024).

Constant feedback is a must when learning a language. AI tools and platforms provide multiple modes of continuous feedback to the students. Chatbots, voice assistants, and writing assistants are examples of continuous feedback for language learning.

Google Assistant builds dialogue scenarios that reflect everyday situations, like traveling or eating out. It helps students with pronunciation and vocabulary while tracking their progress (Xiaofan & Annamalai, 2025). These systems also adapt guidance to fit students' needs, addressing ongoing errors.

AI promotes access to content in classrooms with possibility of active translation of the languages. It provides translation, summarization, and accessibility features that help bridge communication gaps. Text-to-speech, automated captioning, and translation services enable non-native speakers to engage with lessons, materials, and classmates (Mathai, 2024).

AI is particularly good at improving pronunciation and listening skills, which are often overlooked in large classrooms. Tools like Get Pronounce provide instant, detailed feedback after students record their speech, helping them improve their accent, intonation, and fluency. Immersive platforms like English Central simulate real-world situations, providing learners with opportunities to practice dialogue, comprehension, and spontaneous communication in a safe environment (Peña-Acuña

& Fernandes Durão, 2024). A review found that AI chatbots can significantly boost speaking confidence and performance for ELLs. They offer low-risk chances to practice new expressions and sentence structures (Du & Daniel, 2024).

AI technologies help automate lesson planning, create differentiated materials, and conduct ongoing assessments (Edmett et al., 2024). The differentiated Instructions design is one of the most critical aspects with UDL for effective implementation of inclusive education. AI-driven data analytics provide teachers with insights into individual and group progress, enabling more focused and responsive instruction. However, research suggests teachers need training and support to use AI tools effectively and ethically. They must avoid relying too heavily on technology while promoting digital literacy alongside effective communication skills. Despite its benefits, using AI to support ELLs comes with challenges like reliability, access, and algorithmic bias.

3.3.3 Ensuring Access and Bridging the Digital Divide

Any technological development can be seen as a tool to provide access and bridge the digital divide. According to UNESCO (2024), unless intentional interventions are made during AI integration, existing digital divides, which are reflected in differences in device ownership, internet access, and digital literacy, run the danger of widening educational inequality. Policymakers, educators, and stakeholders must collaborate to eliminate systemic barriers, ensure universal access, and develop essential digital and artificial intelligence skills to promote inclusive and equitable education. Artificial intelligence (AI) technologies can provide tailored and flexible learning experiences for different types of learners, and therefore, they have great potential to reduce access gaps (Osonuga et al., 2025). Various studies are being conducted across the nation to

explore the potential applications of AI in addressing the diverse challenges faced by learners. AI-enabled tools, such as those that facilitate translations, text-to-speech, voice commands, and image recognition, have already made instructional materials more accessible for students with disabilities, language minorities, and those in isolated or impoverished contexts (Bi, 2025). The application of these tools in classrooms, with the help of better-prepared teachers, may prove critical in bridging the learning gaps. The capability of AI systems to generate locally relevant and culturally appropriate learning materials will be especially useful for under-resourced students, filling gaps in a traditional curriculum (Roy, 2024). There is a need to develop more infrastructure to support the availability of resources and facilities for stakeholders. Research has shown that to address the digital divide, we must prioritise infrastructure development. A systemic analysis is required in areas where the availability of online and offline capabilities to support ICT implementation is lacking. Contextualised solutions for developing these capabilities need to be studied, overcoming the socioeconomic barriers. To provide equitable access to all the learners, more in-depth assessments should be done at the stakeholder level.

These goals can't be realized in isolation - governments, public society and technology companies must collaborate. Ultimately, inclusion with AI is more than just practice on technology - it will be contingent on broad fluency with various dimensions of artificial intelligence technologies for thoughtful engagement. With the availability of both personal and institutional digital tools, it is essential that these possibilities are utilised effectively by teachers and students. To leverage the developments of AI in education, teachers, leaders and students need to be prepared with the possibilities and aware of the ethical considerations.

Teachers need to be prepared with the developments of AI in their pre-service courses as well as in-service training programmes related to providing equitable access to learners in and outside the classroom.

Automated grading or language tools can put dialect speakers or students from non-dominant cultures at a disadvantage, continuing educational exclusion unless diversity and fairness are prioritized in AI design and testing. The aim is not just to provide technology but to ensure all learners are empowered, represented, and protected in increasingly digital and intelligent learning environments.

3.4 Learning Pathways

3.4.1 Personalised Learning

AI technologies designed for educational purposes also provide descriptive feedback in real-time across the three learning domains (cognitive, affective, and behavioral) in conjunction with performance dashboards for learners and teachers (Wang, 2024). This enables timely shifts in teaching approaches and customizable learning pathways, which support learners in the mastery of specified learning competencies. Adaptive learning systems powered by artificial intelligence (AI) are changing education by creating personalized learning paths tailored to each student's needs, preferences, and performance. Unlike traditional teaching methods, AI-driven platforms analyze real-time data to adjust content, pace, and assessments continuously. This approach promotes engagement, efficiency, and mastery (Gupta et al., 2024; du Plooy, 2024).

At the heart of adaptive learning systems are advanced machine learning algorithms that track learners' engagement with material. These systems create dynamic learning paths that adjust content and activities in real time. For example, a student who struggles with a math concept may receive extra tutorials and practice problems, while a more skilled learner may work on enrichment activities or progress more quickly (Gupta et al., 2024; Claned, 2024). Adaptive systems include various components. It includes formative assessments throughout

the learning process. This enables the timely identification of learning gaps and the provision of immediate help (Shi & Liu, 2025). AI systems curate multimedia resources, such as videos, texts, and simulations, based on the learner's profile and preferences, thereby meeting individual interests and needs (Gupta et al., 2024). Instant feedback helps clarify misconceptions, motivates learners, and guides personalized revision to improve retention and understanding (du Plooy, 2024). AI predicts learner progress and highlights potential problems early. This allows educators to intervene and customize support (Claned, 2024).

The tailored approach helps maintain a suitable level of challenge, maximizing cognitive flow and motivation. A meta-analysis of 70 studies found that adaptive learning has a positive impact on knowledge retention, problem-solving skills, and self-efficacy in various educational settings, ranging from K–12 to higher education (Divanji et al., 2025). For students with diverse learning needs, including those with disabilities or English language learners, adaptive systems offer essential support and differentiated resources (Sharma, 2024). AI-driven personalized learning pathways support not only cognitive skill development but also social-emotional growth. Recent platforms analyze social-emotional factors such as student motivation, persistence, and collaboration skills to tailor interventions that promote wellness and motivation (Shi & Liu, 2025). This comprehensive approach helps educators develop resilient, self-regulated learners. Additionally, these platforms encourage thematic and interdisciplinary learning by suggesting projects and activities that connect different subjects based on student interests and real-world relevance (Gupta et al., 2024). This connection fosters deeper understanding and practical skills, aligning education with essential 21st-century competencies.

Even with advanced AI, educators are essential for effective adaptive learning. Teachers interpret analytics, tailor teaching strategies, and provide the human connection that AI cannot

replicate (du Plooy, 2024). Proper teacher training ensures that instructors can use insights from adaptive platforms to enhance learning and support students effectively. Educators also play a vital role in ensuring the ethical use of AI, including being aware of data privacy, algorithmic bias, and equitable access to technology (Shi & Liu, 2025; Sharma, 2024).

Adaptive learning platforms face challenges like unequal access to technology, data privacy issues, and the need for diverse content to prevent reinforcing existing biases (Wang et al., 2024). Moreover, the effectiveness of adaptive systems relies on platform design, the quality of teaching methods used, and ongoing monitoring for unintended effects (Sharma, 2024). Looking ahead, trends suggest more sophisticated AI features, such as natural language processing, emotion recognition, and multiple input types, will further refine the customization of learning paths (Claned, 2024). This necessitates the need to prepare teachers at different levels to effectively integrate AI into their instructional designs.

3.4.2 Tutoring, Feedback, and Practice

The management of practice, feedback, and tutoring has been altered by AI technologies. They make it possible to create personalised, dynamic, and adaptable learning experiences. AI-powered feedback tools and ITS give pupils tailored assistance based on their unique needs. Studies have shown that the use of ITS significantly engages students and leads to more productive learning outcomes in less time compared to traditional classroom instruction, as well as when students are studying independently. For instance, an experimental study found that math skills were stronger as a result of AI tutoring than when active in-class learning was employed; however, students were also kept more motivated and persistent (Kestin et al., 2025). The use of Natural Language Processing (NLP) in AI has enabled AI to evaluate writing, suggest grammatical and stylistic changes, and

even provide content improvements, thereby making iterative writing practice and self-improvement easier. The development of platforms like Gradescope and ScribeSense has facilitated the process of grading both multiple-choice and open-ended assignments. Consequently, the teacher's workload is reduced, and students receive valuable feedback. Adaptive quizzes, such as Quizalize, constantly adjust the difficulty of questions and provide educators with analytic dashboards to track class and individual progress in real-time. In addition, affective tutoring systems are attentive to students' emotions, such as frustration or disengagement, and adjust teaching methods accordingly, providing encouragement or simplifying content to maintain motivation and confidence (Létourneau et al., 2025).

Moreover, apart from the uses in tutoring and feedback, AI-enabled learning platforms have the potential to engage learners in focused practice and mastery learning through spaced repetition, personalized drills, and gamified activities that facilitate the reinforcement of skills. Tailored practice problems enable learners to focus on their weakest areas and avoid wasting time on topics they already know, as these problems are based on their previous answers. The use of badges, points, and progress tracking as motivational elements by these AI systems enables learners to persist and engage even more, thereby supporting the development of a growth mindset (Wang et al., 2024).

AI systems collect extensive data on student interactions, errors, and learning paths. Through targeted interventions and curriculum changes, educators can leverage this information (Tan et al., 2024). Real-time dashboards highlight the challenging areas of student groups and display individual misconceptions, enabling teachers to provide the exact instruction and resources needed. Additionally, AI platform-based predictive analytics can locate students who are most likely to fall behind, and consequently, interventions such as peer tutoring referrals or personalised learning plans can be done early (Shi & Liu, 2025).

3.4.3 Predictive Analytics for Performance and Intervention

Artificial intelligence (AI) enabled predictive analytics is an imperative decision-making tool that not only predicts student performance but also provides instant, solution-focused action. Predictive analytics is the utilisation of learner data, in particular, attendance, grades, study engagement, and behaviour, to create predictive models that allow for the prediction of students who are at risk of becoming disengaged or falling behind in school. This enables teachers to customise interventions, which ultimately result in improved learning outcomes (Wang et al., 2024). Predictive analytics utilise machine learning algorithms that detect subtle variations and trends of a dynamic nature that conventional tests or teacher observations could not detect. The goal is to anticipate the future academic trajectory of children and provide assistance before they fall significantly behind. Early identification ensures better utilisation of resources, thereby possibly aligning educational support to the diverse learning requirements of each individual child. For example, some prediction algorithms can identify students who are at risk of failing or dropping out as early as a few months in advance, based on long-term trends in test scores, assignment submissions, and class attendance. This enables schools to step in and provide services such as counselling, tutoring, or individualised instruction, leading to lower dropout rates and higher completion rates. The key to models developed using AI is its ability to dynamically remake predictions in real-time using current data, establishing greater accuracy and ultimately flexibility. Continuous feedback and assessment inform the success of predictive analytics. According to Xu et al. (2025), artificial intelligence (AI) software tracks not only end-of-course grades but also minor signs of participation, such as quiz attempts, discussion contributions, and time spent on assignments. Adaptive learning platforms may rapidly modify instructional

content and notify teachers of new learning challenges. This integration facilitates personalised growth pathways, in which students receive feedback that promotes and directs independent learning, in addition to practice and information specifically designed to strengthen particular areas. Simultaneously, educators gain actionable data insights that help inform decision-making and improve the quality of their interventions. However, predictive analytics should be used with due care and oversight.

The teachers, along with the administrative personnel, will require skills to process data, implement the findings in their daily work, and communicate the findings effectively to students and their parents. Additionally, it is well known that linking predictive systems with the current LMS enhances process efficiency, as it allows for uninterrupted information flow while saving time on managerial duties. Platforms designed with user-friendly interfaces and flexible dashboards motivate teachers to engage more and continue using them. One of the recent developments in predictive analytics involves the use of various types of data, including biometric sensors, eye-tracking technology, and natural language processing. All these are used to make predictions regarding students' engagement and cognitive load (Létourneau et al., 2025).

3.5 Assessment and Evaluation

3.5.1 Automated Grading and Feedback

The use of AI in testing and assessment can revolutionize education in a significant way. Observing what children are taught is crucial because it influences teaching and policy development. With AI, the testing industry is moving towards increased precision, efficiency, and enhanced comprehension of learning potential alongside more thorough assessments of complex skills (Wang et al., 2024). Artificial intelligence grading systems have changed the scope, consistency, and speed of assessment processes. Traditional marking is time-consuming and subjective due to the existence of human biases, especially

when evaluating essays, short answers, and questions that do not have a definitive answer.

One of the applications studied for AI in testing is Automated Essay Scoring (AES). These machines evaluate aspects of text, including syntax, coherence, word choice, and argument structure. To provide an accurate score, they contrast these factors to examples that have been human-graded (Valenti et al., 2003). Some of the recent advances include plagiarism detection and semantic comprehension, which allow AES to provide feedback that helps improve students' performance. Automated grading has more applications than essays. AI is applied in STEM disciplines to grade arithmetic problems and programming work automatically, not just for the accuracy of the task, but also for its efficiency and coding style (Shi & Liu, 2025). Sophisticated AI systems also utilise image recognition to evaluate handwritten notes or diagrams, thereby reducing the manual work for teachers. The advantages of AI grading are numerous: it can be easily scaled up, provides quick results, reduces educators' workload, and offers more uniformity among various graders. Nevertheless, studies suggest that AI grading should not entirely replace human judgment, especially in assessing creativity, the quality of arguments, and evaluations sensitive to context (Wang et al., 2024). School assessments can greatly benefit from the blended use of AI tools and human interventions. Grammar corrections and suggestions for improving logical flow or resolving conceptual misunderstandings may be included in the feedback. This promotes the development of understanding in thought processes. The limitations of human and institutional intervention during assessment with students can be greatly overcome with the help of providing support from AI tools.

3.5.2 AI for Formative and Summative Assessments

Through the introduction of adaptive, continuous, and diversified evaluation techniques that more accurately reflect shifting

learning patterns, AI enhances both formative and summative evaluations. AI's capacity to monitor student performance and engagement in real-time for formative assessments provides teachers and students with useful information. Based on student achievement, embedded assessments in learning management platforms, adaptive quizzes, and intelligent tutoring systems (ITS) modify assignments, promote reflection, and modify challenges (Kestin et al., 2025; Shi & Liu, 2025).AI analytics processes detailed data, such as clickstreams, response times, and error patterns, offering insights into learners' problem-solving approaches and comprehension. Educators are able to use dashboards to follow class trends, see which students may need extra help, and personalize learning. AI chatbots and virtual assistants provide students with unique practice and hints, which increases student independence and motivation to learn. In summative assessments, AI also supports more efficient and equitable administration and scoring of assessments, large standardized tests in particular. Automated grading results in less cost and better turnaround time in scoring exams. AI also allows for remote and flexible summative assessments through behaviour tracking, facial recognition, and proctoring. Multimodal assessments, which may involve using text, audio, video, and interaction data to generate a more comprehensive summative assessment, are an example of a field still in its infancy (Létourneau et al., 2025). AI can assess conversations and interactions within virtual worlds to evaluate collaborative problem-solving, or it can analyse spoken presentations using speech-to-text and sentiment analysis.

3.5.3 Assessment of Creativity, Critical Thinking and Problem-Solving

Currently, higher-order talents such as critical thinking, creativity, teamwork, and social-emotional abilities are being integrated with artificial intelligence. The ability of contemporary AI systems

to replicate real-world scenarios allows teachers to observe how students respond to changing challenges. These intelligent environments utilise the systematically established attributes of creativity, adaptability, and decision-making that are difficult to observe under conventional assessment (Létourneau et al., 2025). For instance, AI is now able to evaluate scientific model development and creative code not only in terms of operational performance but also in terms of metrics such as efficiency and uniqueness. Teamwork skills are assessed as well. AI evaluates communication style, activity level, and conflict resolution procedures in group interaction using approaches such as natural language processing and network analysis (Siddiqui, 2024). The obtained data give teachers a more detailed description of the group activity and social skills (Wang et al., 2024). Recent platforms combine algorithms that evaluate empathy, resilience, and self-management, which are important social-emotional learning outcomes (Létourneau et al., 2025), and holistic education. This knowledge can be used in counselling and behavioural intervention. Despite these advancements, problems persist. AI-based assessments must be carefully compared with expert opinion to ensure they can accurately assess emotional and creative abilities. Furthermore, the analysis of biometric or socioemotional data raises significant ethical concerns, including the requirement to obtain explicit consent and a high degree of privacy protection.

3.6 Professional Development of Teachers

3.6.1 Training Programs on AI Tools and Platforms

The adoption of Artificial Intelligence (AI) in education requires robust training for teachers. Such programs can help build the skills and confidence they need to use AI tools effectively. While AI seems helpful in education, research suggests a key problem

is that many teachers don't have enough AI familiarity, tech skills, or AI-related teaching methods, and there is a resistance to using AI. Teachers often feel unsure about how to select the right AI tools, address moral questions, and understand how AI may impact student motivation and learning outcomes. This skill gap may cause AI to be misused or underutilised, which hinders its effectiveness and widens existing gaps. Therefore, it's key to create AI training that accommodates different experience levels, ranging from novice to expert. This helps teachers become leaders in AI learning, not just passive users (Miao & Cukurova, 2024).

Good AI training should focus on multiple aspects beyond skill-building among the teachers. Building the competency of teachers is primary for giving confidence to use AI tools effectively with students. Removing the fear of using technology is crucial for enhancing acceptance among teachers. The doubts need to be addressed at different levels to overcome any barriers that exist in the implementation of AI tools. It requires a very balanced approach from the trainers, as they should not only focus on skill building but also on addressing the doubts among teachers and students. Hands-on sessions where teachers learn about AI platforms, such as tutoring systems, AI grading, or content suggestions, can grow their confidence in using these tools. A key training point is adapting teaching styles to leverage AI's capabilities. Training also includes talks on privacy, bias in algorithms, and the responsible use of AI. This provides teachers with tools to address moral issues and incorporate these topics into the classroom. Due to the rapid evolution of AI, training should encourage teachers to continue learning through online groups, mentoring, and flexible lesson formats. This setup enables teachers to share ideas and develop their skills (Miao & Cukurova, 2024).

Ways of learning that mix in-person sessions, live online talks, and online courses can facilitate access for teachers, fitting their schedules. Providing small credentials and certificates for AI skills can encourage teachers to join and showcase their

progress. Furthermore, incorporating AI training into teacher programs ensures that new teachers are well-equipped for AI-filled classrooms (Dilek et al., 2025). Working together across schools, areas, and tech groups creates connections between ideas and real-world applications. Studies have shown positive results from AI training for teachers, including increased confidence, enhanced technology use, and increased student interest. One study found that teachers who went to AI workshops were quicker to use AI tools for grading and personalized teaching, boosting student drive and test scores. There are still challenges in growing AI training, especially in areas that lack the necessary tools, funding, or skilled trainers. Additionally, concerns about job changes and technology gaps need to be addressed through programs and discussions with all parties involved. For AI training to be effective, it should align with educational plans, cater to local needs, and have adequate funding (Miao & Cukurova, 2024). Regular checks and feedback are crucial for adapting training to accommodate AI changes.

3.6.2 Streamlining Administration and Planning

Artificial Intelligence (AI) has significantly enhanced efficiency in education, not only in the classroom but also by streamlining administrative and preparatory tasks. These technologies help educators and school administrators automate routine, time-consuming activities. This enables teachers to focus more on engaging with students and delivering high-quality lessons (Wang et al., 2024). AI-powered automation is becoming an integral part of managing workload sustainably as educational systems become increasingly complex. Administrators and teachers dedicate a significant amount of time to tasks such as timetabling, maintaining attendance records, marking, designing curricula, and managing communication. These processes are automated using AI-powered systems, along with smart workflow

management tools, robotic process automation (RPA), and natural language processing. AI-powered scheduling tools, for example, create optimal schedules considering resource constraints, class capacities, and teacher availability. This reduces manual errors and conflicts (Miao & Cukurova, 2024). Automated student attendance systems utilise facial recognition or proximity sensors, linked to AI analytics, to provide real-time information on students' presence and punctuality. Additionally, chatbots and virtual assistants manage common inquiries from students and parents about deadlines, syllabus details, or school event schedules. As mentioned earlier, AI systems allow automated grading for multiple-choice and even open-ended responses, providing timely and consistent evaluations (Xu et al., 2025).

AI applications assist teachers in designing curricula by analyzing student data trends. They recommend suitable instructional content, identify gaps, and align materials with standards (Dilek et al., 2025). AI-generated resources like customized quizzes, multimedia lessons, and scaffolded activities enable teachers to quickly and effectively personalize learning materials. Platforms also help educators curate and adapt open educational resources (OERs). This allows them to filter content relevant to learners' cultural backgrounds and abilities. This increases inclusivity and boosts engagement (Miao & Cukurova, 2024). Large educational datasets are gathered and analyzed using AI to aid in strategic decision-making at the institutional and policy levels. School administrators can monitor staff workload, behavioural problems, attendance patterns, and performance using administrative dashboards with AI analytics. AI's predictive powers draw attention to new issues and direct the distribution of resources and focused assistance. Adoption is hampered by infrastructural constraints, data privacy concerns, and the requirement for teacher training on analyzing AI-generated insights, despite the substantial administrative savings that AI offers. Strong governance structures are essential to address ethical concerns regarding consent and surveillance,

thereby safeguarding the rights of all parties involved (Holmes et al., 2019).

3.6.3 Continuous Professional Development

With the increasing application of artificial intelligence (AI) in education, teachers must commit to continuous professional development (CPD) and lifelong learning to keep pace with evolving technology and pedagogical methods. AI can transform professional learning styles and be a subject of ongoing education. For teachers, it promotes collaboration, flexibility, and self-development (Miao & Cukurova, 2024). Artificial intelligence-driven learning management systems (LMS) with the ability to adapt to teachers are Canvas, Blackboard, and Moodle. They identify areas of skill deficiency, suggest tailored courses, and track progress over time (Wang et al., 2024). To facilitate self-learning and self-reflection, these systems also incorporate AI chatbots and virtual mentors that provide resources and assistance as needed. AI models driven by performance data, peer evaluation, and class analytics enable CPD programs to respond dynamically to the unique needs and ambitions of teachers (Dilek et al., 2025). Personalised recommendations help educators choose relevant workshops, micro-credentials or peer learning communities that focus on pedagogy, digital literacy or AI ethics. This personalised approach to professional learning is key to motivation and relevance, the two main drivers for ongoing engagement and better practice. AI is key to professional collaboration as it recommends peer connections, facilitates online discussion forums and supports communities of practice through semantic and Social Network Analysis (SNA) (Holmes et al., 2019). These networks enable the sharing of best practices, co-creation of resources, collective problem-solving, and a culture of continuous improvement. AI also supports reflective practice by analysing classroom videos, audio or transcripts. This provides teachers with valuable feedback on their instructional

and interaction styles. Reflection is key to metacognitive growth, which is essential for professional expertise. As AI and related technologies continue to evolve, ongoing updates to digital and AI literacy are essential for teachers and school leaders. CPD should focus on understanding ethical AI, critically evaluating AI tools and creating strategies that respect learner diversity and equity (Miao & Cukurova, 2024). Continuous learning empowers teachers to counter AI biases and advocate for inclusive technology design and implementation. AI-powered needs assessments can help identify these barriers and suggest tailored interventions. Embedding AI CPD into school cultures, policy frameworks and teacher preparation programs ensures its legitimacy and sustainability. Microlearning modules, mobile access and blended learning options make it more accessible, especially in resource-poor settings. Future developments may include AI simulations that replicate classroom challenges, allowing teachers to learn by doing in a safe environment (Holmes et al., 2019). Technologies that recognise emotions and engagement will further support teacher well-being and professional resilience, which will increase transparency and trust. This will help educators understand AI recommendations and make informed choices about their professional growth.

4

Future Discourse and Direction of Education

4.1 Emerging AI Technologies

4.1.1 Generative AI and Large Language Models (LLMs)

Generative artificial intelligence (GenAI) has the potential to be highly transformative for education, such as Large Language Models (LLMs) which utilise large datasets, can generate contents like natural language, images, and code. Unlike earlier AI tools, generative AI produces new content that is practically indistinguishable from human output. This function is important for revamping the educational model that extends beyond managing administrative routines to engaging in the educational work of knowledge production. For teachers, LLMs can generate multiple examples that cater to diverse cultural contexts. They can formulate questions for formative assessment, automate assignments that involve thinking about rubrics, and differentiate reading materials for varying proficiency levels based on the needs of the students. These capabilities increase educator preparation efficiency, allowing them to focus on higher-order

teaching and instructional needs (Kasneci et al., 2023). On a deeper level, GenAI facilitates engagement for students in the sense that they are not passive receivers of knowledge, but rather, they co-design knowledge in collaboration with others. Examples of using LLMs include brainstorming partners, simulated expert-dialectic peer dialogue, and fixing knowledge issues, as it provides quick explanations (Monib et al., 2024). These exchanges allow students to interact without risk and to self-quiz about what they know or do not know with the material dialogically. Studies have shown that students can often complete more imaginative and advanced work when collaborating with AI. Personalisation is among the key features of this technique (Mollick & Mollick, 2023). An LLM can generate explanations adapted to a student's level of knowledge, give individualised feedback on writing, or generate practice questions tailored to particular areas of weakness. This tailor-made scaffolding allows learners to get the right support at the right time, leading to an effective, fair and efficient teaching-learning environment (Ayanwale et al., 2025). GenAI's conversational style assists in cultivating higher-order inquiry skills. AI-enabled conversational agents and virtual tutors can engage learners in complex conversations that enhance critical thinking and metacognitive skills and serve as "always on" learning partners outside the physical school hours (Bettayeb et al., 2024). These could be Socratic partners in design. They pose tough questions that challenge students to re-examine their assumptions and tell them why they think what they think, instead of simply telling them what to think. This strategy is similar to the cognitive apprenticeship model, where learners develop expertise by performing complex tasks with the help of AI.

This process enables the development of a number of exploratory metaskills, which include asking the right questions or making integrations. This process facilitates creative questioning and critical thinking. They improve their writing of specific prompts (text queries). This process, which involves asking questions, evaluating, and refining, allows them to move

from a shallow understanding to a deeper understanding of the topics. The agents serve learners with different linguistic and cognitive profiles, which facilitates inclusion in a multilingual context (Ayanwale et al., 2025; Lai & Lee, 2024). However, the LLMs raise ethical issues, which underscores the importance of verification and critical reasoning by humans.

4.1.2 Immersive Learning with AI-driven VR and AR

The integration of AI and other immersive learning tools, such as VR and AR, is opening up new avenues for hands-on learning. Immersive learning technology enabled by AI not only revolutionizes learning environments by developing them but also helps them perceive and respond to learners' actions and interactions in real-time. This is not just an extension of learning visualization technology but offers completely flexible learning environments. It offers personalized learning, skill learning, and dimensional assessment across multiple fields of learning. Perhaps one of the major advantages of learning with AI is the ability to engage with dynamic simulations designed for intensive learning areas where practice is too costly and dangerous (Yakkala, 2024). AI-enabled virtual science labs allow learners to carry out complex learning scenarios in a safe and realistic manner. The AI technology can create scenarios that adjust according to learners' performance. If the learner is good at a simple titration learning scenario, the AI technology can introduce new variables to help them excel further in the same scenario.

Historical simulations carried out through AR/VR technology may include Non-Player Characters (NPCs) created through AI technology that can interact with teachers and provide answers to the queries of the students convincingly, thus creating a deeper insight into complex decision-making processes (Pantelidis, 2010). By making virtual worlds more responsive

and less predictable, AI creates a safe environment of exploration, experimentation, and understanding of the topic or subject of interest. AI is uniquely suited to provide personalized assistance within the virtual experience in a real-time, synchronous, and multimodal way. AI can analyse continuous streams of data, such as users' facial expression, physical movements, and how they perform in tasks, to recognise individual learning needs. Then, they also adapt the clues and task's complexity (Omar et al., 2025). This support gradually decreases as learners acquire skills to promote learning autonomy and facilitate long-term retention. On the other hand, natural language processing (NLP) powers conversational AI agents who give feedback (Wang, 2024). It also strengthens support for skill-based areas. However, the literature cautions against an over-dependence on AI support, as inappropriate scaffolding may hinder metacognitive development (Omar et al., 2025).

4.1.3 The Future of Personalisation: Affective Computing and Explainable AI (XAI)

As artificial intelligence becomes more integrated into education, the focus on personalisation is shifting; it now encompasses emotional and cognitive dimensions of learning. Affective Computing and Explainable AI (XAI) are two related fields that are bringing about a new era of trust, engagement, and teaching methods. Affective computing lets schools and other educational systems figure out how students and learners are feeling and respond to them. On the other hand, XAI makes assessments and recommendations that use AI in a more open and trustworthy manner. These two interrelated domains collaborate in a fundamental role to cultivate ethical and proactive AI-integrated learning environments. Affective computing aims to equip machines with the capability to perceive, comprehend, and replicate human emotions, especially within educational contexts (Vistorte et al., 2024). The field is exploring how

machine learning and deep neural networks can be used to process various inputs, including facial expressions, voice tone, etc. By analyzing this data, this technology aims to determine students' emotional states and inform the learning environment accordingly. Systematic reviews indicate that these technologies can reliably identify essential emotions such as boredom, frustration, and engagement. Advanced models can also decode states of confusion or happiness from facial and vocal patterns over 90% accurately (Vistorte et al., 2024). This is important because learning is dependent both on thinking skills and on emotions, motivation, attention, and memory.

Moreover, the technology promotes greater accessibility for neurodiverse students, as it responds to various emotional signals, thereby creating a psychologically secure environment (Vistorte et al., 2024b). However, this needs to be complemented by strong safeguards to address critical issues of privacy, cross-cultural applicability, and responsible use, particularly in dealing with sensitive biometric data. As the size and complexity of AI models increase, it becomes very difficult for users to trust the technology because of its inherent "black box" nature, particularly in critical educational scenarios such as assessments. Explainable/Transparent AI (XAI) attempts to address this very critical concern of users by making the AI transparent to users. It provides relevant explanations for automated decisions, results, and learning recommendations. This is critical in terms of equity, educational worth, and legal requirements. Recent findings suggest that more interpretable and transparent explanatory systems are more acceptable and trusted by educators and learners (Altukhi & Pradhan, 2025). Some of the significant XAI techniques include feature attribution, which helps us understand what are the major contributors to an outcome, interactive visualization, and open learner models, which enable learners to view and dispute decisions made by machines. For instance, an XAI-assisted essay-scoring device not only provides a grade but also helps us understand which sentences demonstrate a strong

argument and which ones demonstrate poor evidence. This methodology assists learners and instructors in reviewing AI recommendations rather than simply accepting them. XAI has already been used in devices that assist learners in understanding the detection of errors, making them more useful and fairer. Even though XAI assists stakeholders in increasing trust within AI systems, there are still significant challenges to be addressed, such as making decisions regarding the balance between the accuracy of predictions and the ability to explain them to non-experts (Altukhi & Pradhan, 2025).

4.2 Learning with AI and Learning about AI

4.2.1 From AI as a Tool to AI as a Collaborative Partner

The importance of AI in education is shifting from peripheral to central role in the learning process. This is because of the growing shift towards hybrid models of humans and AI. It focuses on the augmentation of learners' AI interaction and the collaboration of Learners and AIS, aiming to improve learners' engagement, creativity, and self-reflection (Kovari, 2025). With the evolution of AI technology, education uses AI to improve human cognition. The paradigm of "AI as a tutor" is shifting towards "AI as partners." AI can function as a catalyst for creativity, a co-learner, and a mirror for self-reflection (Zawacki-Richter et al., 2019). A successful intervention is project-based learning to develop AI-based chatbots for social good.

Students can also collaborate, code, and test the bot repeatedly while considering the data bias, user experience, and ethical perspectives. This methodology can assist the members of the groups in learning the value of creative problem-solving and empathetic learning; that is, it will show them the value of well-designed AI curriculum units. This series of assignments helps the students develop the civic and personal aspects of

AI skills, which can be achieved through interdisciplinary learning. This improved PBL assistance can be achieved with the aid of this new methodology, which can assist the students in understanding and controlling their learning process. In order to utilize the capabilities of AI as a co-creator and co-learner, the PBL methodology can be implemented, which can assist the students in participating in the resolution of real-world problems. In this particular case, the roles that can be played by the AI can be cooperative, which can assist the students with autonomy instead of replacing it. Consider the "AI as a Socratic Teammate" framework, which considers the role of the AI as a questioner rather than a provider of information.

For example, within a science PBL project, an AI might evaluate a student's research plan and then pose the question, "What assumptions are underlying your hypothesis?" The theory behind this type of question is to break away from instant judgment and create a feeling of connection to the work. Studies show that this type of interaction significantly helps to create critical thinking skills and project ownership (Shahzad et al., 2025). The other paradigm that has significant influence is "AI as a Creative Co-Conspirator" for brainstorming and ideation (Akomodi &Abdullah, 2025).

Generative AI offers an abundance of alternatives in a very short time, a powerful stimulus for student creativity. For example, students may ask an LLM for some rough ideas which they take, critique and refine. Such an approach mirrors professional contexts as it takes away the burden of idea generation so that students may allocate their time and energy to higher-order cognitive tasks of developing and integrating strategic and creative problem solving. As an AI Thought Partner, students have cognitive and creative augmentation and expansion (Chen et al., 2020). In order to formally recognise and acknowledge that students used artificial intelligence during the brainstorming and editing stages of their projects, a number of futuristic schools are making changes to their project

checklists and rubrics. This exemplifies how to take advantage of AI's collaborative potential. Moreover, complex tasks that necessitate separating work performed by AI and humans can be tackled using a "Distributed Intelligence" model. In this case, students could use AI to tackle vast amounts of data-ladden interpretation while concentrating on the patterns that the data represents (Ouyang et al., 2022). Recommendations for teaching suggest that human feedback should be co-mingled with the AI support and that students continue to be responsible for their learning. Metacognition, the ability to be aware of and control one's thinking processes, is an essential lifelong learning skill. There is an emerging trend for using AI to facilitate such competencies, as a "metacognitive mirror" to monitor, evaluate and regulate students' learning strategies (Roll & Wylie, 2016). For instance, conversational AI tutors can prompt students to reflect on their problem-solving processes during reflective conversations, posing questions like, "Could you explain your thought process?" This "externalisation" of students' thinking allows them to reflect and improve. Recent research shows strong positive correlations between AI-based metacognitive support and student autonomy/independence (Roll & Wylie, 2016). According to one study, personal AI feedback greatly supports the development of metacognitive skills and positively influences planning and monitoring as aspects of metacognition. This is frequently done via learning analytics dashboards, powered by AI, that visualise student behaviours. When progress is made visible to students, these instruments influence the way they study. These systems may also detect maladaptive patterns and suggest time-critical interventions to cognitively and emotionally support the users. Lastly, AI can facilitate metacognition via simulated teaching or explaining activities. The evolution of AI in education, from passive instrument to active collaborator, is transforming how we teach. With human-AI collaboration and metacognitive support, we design meaningful learning experiences.

4.2.2 Advanced AI Literacies for Deeper Understanding

Strong AI competencies in the new world of AI and education are needed to enable learners to grasp AI's technical, ethical, and social dimensions. A straightforward understanding treating AI as a "black box" will no longer suffice the greater depth of engagement, learners and citizens require (Long & Magerko, 2020). Therefore, attention must be directed to core knowledge of neural networks, machine learning concepts, and critical thinking regarding AI ethics (Ng et al., 2021). These capabilities enable learners to employ AI tools appropriately and critically examine AI systems. The foundation of AI technologies is neural networks and machine learning (ML), which allow for most applications that the learner will encounter. Neural networks, which are drawn from nature, are composed of interconnected nodes that carry out data processing in various layers to recognise patterns. Being aware of the value of data, how it is collected and labelled, and what biases it has provided enables the students to be critical consumers of outputs from AI.

Students must know that AI systems are developed based on the training data, and an AI's weaknesses and strengths reflect the data they were trained on. This is important because it tells us how an AI "learns" on massive datasets that may have been tainted with bias due to historical wrongdoing and used to influence that AI's fairness and reliability. Teaching good AI literacy involves combining computing thinking and data-related skills with interactive visualisations and simulations to teach complex ML concepts and keep students actively engaged (Kalantzis & Cope, 2025; Ng et al., 2021). High-level AI literacy may need to cover ethical concerns with using and implementing AI beyond the technical competencies (UNESCO, 2024).

Learners should delve into the potential roots of bias, like data sampling and model training, methodologies for assessing fairness and strategies to mitigate bias. The ethics-related values

of transparency, human oversight and explainable AI (XAI) must be considered in the high-stakes implementation areas. However, the realisation of this dream solely hinges on how well teachers are empowered. Research shows that much needs to be done to empower teachers regarding diversity and inclusion (Allen & Kendeou, 2024). Frameworks such as the AILit Framework guide the ethical use of AI tools across all grade levels and curriculum areas (Kalantzis & Cope, 2025).

4.3 Learner Competencies in the Age of AI

4.3.1 Developing Learner Competencies with AI

The integration of Artificial Intelligence (AI) in education presents transformative opportunities to develop essential learner competencies crucial for the 21st century. These competencies include critical thinking, problem-solving, creativity, collaboration, communication, self-regulation, and ethical awareness, skills that AI-enhanced pedagogies can scaffold more effectively than traditional methods (Wang, 2024; Pallant et al., 2025). Unlike prior technology shifts, AI's ability to personalise, adapt, and provide formative feedback enables more nuanced and learner-centred growth in competency. Competency has historically concentrated on particular areas of knowledge and specific skills, but the use of AI technology on learning tools and platforms requires the consideration of cognitive, metacognitive, socio-emotional, and ethical aspects (Siemens, 2013). More remarkably, the cornerstones of adaptability and the orientation towards life-long learning are essential for students to capture the value and cope with shifting technologies in the workplace. The capacity of AI to offer contextual and adapt learning opportunities strongly aligns with the aforementioned competencies and promotes co-knowledge creation while fostering resilience in learners (Zaharuddin et al., 2024). Careful integration of AI in inquiry- and project-based learning fosters

metacognitive thinking, hypothesis testing, and evidence-based reasoning across the curriculum. Through real-time analysis of learner data, AI systems identify specific strengths and weaknesses, offering tailored support to optimize knowledge acquisition and skill development (Zaharuddin et al., 2024). This responsive feedback can enhance motivation and involvement, which are crucial factors for developing competence over time (Zaharuddin et al., 2024). In order to ensure the development of healthy and constructive social decisions, it is essential that the methods applied in education become more future-oriented, with a focus on the inclusion of ethical education and AI foresight, as well as opportunities for transparent analysis of AI outputs and their effects.

The inclusion of artificial intelligence technologies in education strengthens the circular movement of the education system, which is oriented towards competency-based education, as it breaks the vis-à-vis relationship with standardized tests by providing diverse and comprehensive evaluation opportunities. The inclusion of AI technologies also strengthens the diversity of assignments that learners have to complete for formative evaluations, such as the development of education portfolios, as well as project-based teaching and learning assignments that focus on the development of the holistic education concept, as envisioned by the National Education Policy (NEP, 2020). This provides personalized and meaningful recognition of the capabilities of learners, which is more personalized and meaningful than just focusing on growth and achievement. While AI technologies provide substantial learning advantages, nurturing social and interpersonal skills remains a vital, parallel focus for achieving holistic development.

4.3.2 AI-based Learner Competencies

The AI learner competencies include the ability of learners to understand, use, evaluate, and collaborate with AI systems

responsibly within an educational setting. Some of the identified learning capacities developed by AI include learning and participation capacity overall and a focus on technical, ethical, and social-emotional learning capacities. These learning capacities are particularly needed amongst learners. Learners need to interact with AI systems constructively and responsibly (Zhou et al., 2025).

The global frameworks include UNESCO's AI Competency Framework (2024) and the American University's Framework for AI Literacy, which give a holistic view of learning capacities related to AI systems. These capacities include technical knowledge of AI systems (understanding how AI works, how data is processed, and the limitations of algorithms); applied learning capacities (computational thinking, data literacy, and critical engagement with AI systems); and ethical and reflective learning capacities (understanding AI's influence on society, ethical uses of AI systems and tools, transparency, fairness, and accountability).

This multidimensional approach is different from some of the other 21st century constructs in the sense that it embeds AI literacy within modern citizenship, academic success through lifelong learning (European Commission, 2019). International frameworks, including the UNESCO AI Competency Framework, OECD AI Literacy Blueprint, and the ISTE AI Standards, outline AI-related learner competencies that encompass the need for particular technical knowledge, ethical engagement, and individual agency while engaging with AI. In the educational contexts of India, new and innovative ways should be developed to implement the frameworks. This use of contextualised content allows Indian learners to build the skills that are required to address local issues while also positioning them for global citizenship and success in the international AI driven workforce. The AI competencies also include computational thinking, or the ability to break down the problems in a way an AI system is able to comprehend. This includes skills, namely, decomposition,

pattern recognition, and algorithmic reasoning, all being important aspects of engaging with AI (Zhou et al., 2025). Data literacy runs parallel to computational thinking and refers to skillfulness in reading, analyzing, and assessing data within its intended context. It also includes recognizing bias and evaluating data credibility. Learners who are proficient in data literacy can engage with AI-based decision-making and output more meaningfully, as they can ask questions out of recommendations made by AI, instead of accepting them purely on the basis of authority. Ethical literacy is a critical element of AI-based competencies. Learners must understand the complexities of privacy, equity, transparency, and larger societal issues related to AI tools (European Commission, 2019). UNESCO's frameworks reinstate that ethical reflection in AI learning is core to working with AI tools. It is also central to responsibly manage the effects of AI tools. Pedagogical research supports that the best approach for developing ethical competencies is through experiential, constructivist-based strategies that require learners to engage as designers, critics and evaluators of AI systems that allows personal engagement with ethical issues and increased moral agency (Gouseti et al., 2024). These may include self-regulation, digital well-being, empathy and social awareness to understand implications of AI engagement in shaping communication and decision-making (Zhou et al., 2025). Creating self-awareness, ownership of the AI tool engagement, empowers learners to practice responsible digital citizenship. Classroom educators' voices and practices are crucial in providing practical approaches to develop AI-based skills. For instance, in a pilot study, students from urban schools participated in "Algorithmic Fairness Labs," where they audited algorithmic decision-making and communicated their findings through ethical debates. These exercises also support critical thinking and computational reasoning. They are correlated with measurable increases in digital agency and moral awareness (Gouseti et al., 2024).

5

Case Studies and Best Practices

This chapter has compiled examples, policies, and best practices from India and other countries to show the effectiveness of AI to improve education and teacher preparation. To juxtapose global developments with India's own progress, this works brings the perspectives to understand the Indian progress and potential progress. These global case studies demonstrate that AI can be deployed to enhance personalized learning, reduce teachers' workload, and augment decision-making in academic institutions. These success stories and feedback offer telling lessons for India, especially as we cope up with challenges such as jumbo classrooms, diverse languages, and inequitable access to technology. Further, these research viewpoints from this part of the work are supposed to excite the Indian academic community in comprehending the gaps and developing indigenous solutions. This will assist in deploying hands-on and ethical ways to integrate AI into teaching and teacher education programs. It also helps to build a powerful, inclusive, and futuristic education delivery system for the country.

5.1. Global Case Studies: AI Integration in Education

The EU's plan Artificial Intelligence for Europe (2018) has mapped out a three-part strategy: (1) augment technology and

industry with financial support for research, innovation, and open access to data, including public records; (2) get ready for upgrades by evolving education, educating new talent, providing logistics for the job shifts, and fortifying social safety nets; and (3) construct a fair and ethical/moral legal system based on the EU Charter of Fundamental Rights, with stipulations for the product safety, ethical/moral guidelines through the European AI Alliance (a group of experts, businesses, and citizens), and collaboration across sectors (European Commission, 2018).

The idea of *human-centered AI* designing tech to cater to academic needs and to recognize their limits is central to a 2024 Council of Europe study, covering 46 countries focused on human rights, democracy, and law. It alerts that a large number of AI tools in schools lack reliability and consistency, safety, or equitability, which can incur biases, privacy violations, or a substandard teaching standard (pp. 15-17). Childerns, protected by the United Nations Convention on the Rights of the Child (UNCRC, 1991) and the European Convention on Human Rights (ECHR, 1950), are especially at state from the "black box" AI systems which are so complex that no one can explain them and they might ignore the *diversity* (different ways children learn, like with ADHD) or even exacerbate the *digital divide* (where some children lack access to tech) (pp. 15, 22). While General Data Protection Regulation (GDPR, 2016) helps protect data, it doesn't cater to education's unique and peculiar needs, like teaching children to brood critically or keeping greedy companies from profiteering off their personal data (pp. 16, 29-31). The study puts together a clarion call for an innovative law that balances risks and rights, to ensure AI transparency, accountability, and fairness with solid evidence that it works and indeed accepts and assimilates inputs from students, teachers, and parents (pp. 36-38). This *ecosystemic perspective* visualizes education as a web of academic stake holders, technology, and values, providing a just balance between innovation and ethics and even considering AI's gigantic power consumption leading to global warming (pp. 9, 40).

"While AI potentially offers opportunities to improve educational outcomes, its application requires careful regulation to prevent harm, protect human rights and ensure equitable access to educational benefits" (Council of Europe, 2024, p. 10).

The European Commission's Joint Research Centre (JRC) report (2018) delves into AI's contribution in education, going beyond the raw excitement and scepticism. It highlights ground breaking developments in machine learning, powered by modern computers and vast pools of data, with killer applications like online real time translation or self-driving systems. AI can mechanize boring tasks, personalize learning, and drive job markets crazy studies conclude that half of jobs in developed countries could be automated but nothing of that sort has happened so far and it seems more like a hype than reality. But AI isn't that great either; it can pick up biases from outdated obsolete data and super simplify how people learn, losing out on *socio-emotional learning* like teamwork or motivation. The report juxtaposes AI to "the next electricity"—a gigantic change that needs temporal and spatial resources. It pushes for progressive steps, like standardizing AI in schools through the Digital Education Action Plan, creating shared EU data platforms for ethical/moral AI, and documenting its cognitive impacts through projects like HUMAINT. It also calls for pedagogical innovation, like deploying AI to create virtual student profiles for effective evaluation, while managing biases in how AI learns (JRC, 2018). AI is now often called 'the next electricity.' The shape shifting effect of general-purpose technologies, like AI, however, becomes noticeable only gradually, when societies and economies evolve as users of new technologies (JRC, 2018).

The OECD's Digital Education Outlook 2023 looks at how countries have gone digital due to COVID induced lockdown measures, with online classes, student tracking systems, and AI-powered personalization. The true objective is *digital transformation*—redesigning academics to have a deep impact, especially through personalized learning. There are obstacles:

tools that are not compatible, privacy concerns, choppy internet, and instructors who need appropriate skills. Only 9 of 18 countries have broad AI guidelines. The report advocates a bird's eye view approach, pointing to models like Iceland's INNA system for providing the logistics for student data, customizable platforms, state of the art internet for all, and teacher training like Austria's Digi.kompP. It also presents ethical/moral AI rules, stressing the need for supporting teachers, managing biases, and guaranteeing privacy (OECD, 2023).

"The main benefit of a digital transformation lies in the personalisation of education, both in terms of learning and of student support" (OECD, 2023, p. 3).

The Beijing Consensus of 2019, from a UNESCO conference in China, is the world's first global agreement on AI in education, tied to the UN's Sustainable Development Goal 4 (SDG 4) for equitable and personalized education. It takes a *humanistic approach*, using AI to augment cognitive development while managing issues like ethics, privacy, and unequal access, leveraging the 2015 Qingdao Declaration. It encourages countries to create AI plans, guarantee that everyone can use AI tools, educate and skill teachers to use AI appropriately, and monitor ethics. UNESCO's role is to guide, set standards, and inspire global conversations (UNESCO, 2019). We need to direct this revolution on the right path, to provide better livelihoods, to reduce inequalities and guarantee a just and inclusive globalization (UNESCO, 2019).

"Ensure that AI tools in teaching and learning enable the effective inclusion of students with learning impairments or disabilities and those studying in a language other than their mother tongue" (UNESCO, 2019 p. 7).

UNESCO's (2021) AI and Education: Guidance for Policy-Makers helps leaders use AI to meet SDG 4, alerting the risks like biases and inequality. It provides three ways to approach AI: static policies, mixing AI into education plans, or stressing on specific uses like customized learning. It suggests building

skills, measuring risks, putting together ethical rules (like fairness and clarity), working with businesses, and upgrading tech access (UNESCO, 2021). The 2022 K-12 AI Curricula Mapping provides insights at how countries teach AI in schools, covering basics, real-world uses, ethics, and skills, pushing for practical, just learning (UNESCO, 2022).

"The deep amalgamation of AI in education has the capability to deal with some of the biggest obstacles in education today, update teaching and learning practices, and galvanize the progress towards SDG 4" (UNESCO, 2021, p. 10).

UNICEF's 2021 *Policy Guidance on AI for Children 2.0*, created with Finland, focuses on childerns' rights under the UNCRC, listing nine essentials: accelerating cognitive growth, insensitivity, fairness, securing data, guaranteeing safety, clarity, preparing kids, advancing them for the future, and generating support systems. It provides incentives for testing AI and engaging kids in its design (UNICEF, 2021). The World Economic Forum's 2022 *AI for Children Toolkit* manages AI in apps, games, and toys, using the *FIRST framework* (Fair, Inclusive, Responsible, Safe, Transparent) to lead ethical design with tools like checklists and labels (WEF, 2022). AI must be guided and used in ways that accelerate children's holistic development, well-being and rights (UNICEF, 2021, p. 8).

"The ultimate purpose of the guidance is to aid the protection and empowerment of children in interactions with AI systems and enable access to its benefits in all aspects of life" (UNICEF, 2021, p. 8).

All these international perspectives have a common view that the systematic amalgamation of AI in education has the capability to deal with some of the fierce obstacles in education today, upgrade teaching and learning practices, and ultimately speed up the progress towards SDG 4 (UNESCO, 2021, p. 10), provided its deployment is human-centric, ethical, and sustainable (European Commission, 2018, p. 2), securing the rights and welfare of children and society.

5.1.1. Key Interventions: Connecting Ideas for Ethical AI in Education

AI has deep potential to transform education by customizing learning, supporting inclusion, and upgrading system-level decision-making. They also stress that such metamorphosis is meaningful only when AI remains human-centric, ethical, and aligned with principles of fairness, transparency, and accountability. Together, these international rule-books demonstrate that the true contribution of AI in education emanates not from technological prowess alone, but from how responsibly and thoughtfully it is amalgamated into teaching, learning, and governance. This evolving global consensus provides an important foundation for India as it builds its own contextually relevant, equity-driven approach to AI integration in teacher education and school systems. They connect through key ideas and actions:

- **Proof Before Use**: Test AI thoroughly to guarantee that it helps learning and is safe, like testing a new medicine before it's sold (Council of Europe, 2024; UNESCO, 2021).
- **Fairness and Safety**: Manage biases, make AI clear, and protect against harm, like guaranteeing no kid is unfairly judged by an algorithm (EU AI Act, 2024; OECD, 2023; WEF, 2022).
- **Include Everyone**: Involve students, teachers, and parents in training and monitoring AI, and encourage AI skilling to all (Beijing Consensus, 2019; UNICEF, 2021).
- **Equal Access**: Make AI deliver for everyone, including Divyang kids with no internet, to bridge gaps, not exacerbate them (UNESCO, 2022; OECD, 2023).
- **Smart Policies**: Develop clear rules and calibrate AI in real schools, developing new horizons ahead to keep education fair and independent (EU, 2018; JRC, 2018).

5.1.2 Global AI in Education Frameworks (*Appendix A)*

There is a global consensus that Artificial Intelligence (AI) has the potential to transform education by enabling customized learning, enhancing inclusivity, and encouraging efficient school administration, but such metamorphosis is of any use only when AI is human-centric, ethical, and equitable (Council of Europe, 2024; OECD, 2021; UNESCO, 2019, 2021; UNICEF, 2021; World Economic Forum [WEF], 2022). These frameworks guarantee the protection of learner and child rights, calling for transparency, accountability, fairness, and data privacy, while managing risks of bias, discrimination, and digital exclusion. For India, these features are particularly relevant as the country wants to deploy AI in schools and teacher education under initiatives like the National Education Policy 2020 (*Ministry of Education, 2020*) and the National Digital Education Architecture (*Ministry of Education, 2021*).

A focal point for India is the critical role of teachers. Teacher training, AI literacy, and pedagogical readiness are essential to ensure AI tools support teaching and learning effectively rather than replacing human judgment (*OECD, 2021; UNESCO, 2021*). These frameworks feature the capacity building for educators as a requirement for equitable AI adoption in Indian classrooms, particularly in rural and remote under-provisioned areas. The frameworks further outline multi-stakeholder engagement, including governments, educators, students, parents, and industry stakeholders, to create collaborative ecosystems for a healthy AI adoption (*Council of Europe, 2024; UNICEF, 2021; WEF, 2022*). They highlight the importance of regulations, ethics, and monitoring demonstrating that responsible AI requires balancing innovation with learner safety, equity, and accountability (*UNESCO, 2019; UNESCO, 2021*). These frameworks provide a valuable pathway for India, illustrating AI integration in education and that teacher training can succeed only when it is

guided by ethics, inclusivity, and human-centred governance, aligned with national educational priorities and socio-cultural contexts (*Council of Europe, 2024; OECD, 2021; UNESCO, 2019, 2021; UNICEF, 2021; WEF, 2022*).

5.1.3 Gaps in the Existing Regulatory and Policy Frameworks

The global regulatory landscape for integrating artificial intelligence (AI) into teacher education is fraught with significant obstacles, as explains across a range of government and non-government documents. Foremost among these is the absence of universally agreeable ethical/moral guidelines, a concern underscored by UNESCO's *AI and Education: Guidance for Policy-Makers* (2021), which highlights that the rapid proliferation of generative AI (GenAI) technologies moves faster than the development of required policies, leaving critical issues such as algorithmic biases, data privacy and security, and transparency unaddressed (UNESCO, 2021, p. 15). This gap is exacerbated by the lack of agreeable international standards, as noted in the *Beijing Consensus on Artificial Intelligence and Education* (2019), which argues for ethical oversight but lacks enforceable rule-book, resulting in a mix-up of non-binding recommendations across 190 countries (UNESCO, 2019, p.5). Secondly, infrastructure gaps fuel inequity on a global scale, with the OECD *Digital Education Outlook 2023* identifying recurrent connectivity challenges, particularly in sub-Saharan Africa and South Asia, where only 25% of rural schools have proper broadband, drastically limiting AI tool accessibility and engagement for teacher training (OECD, 2023, p. 23). Thirdly, the lacunae in training frameworks is a widespread issue, as the Stanford AI+Education Summit (2025) reports that only 26 of 50 U.S. states and a mere 15% of OECD countries provide detailed AI guidance, rendering educators globally ill-prepared for tools like ChatGPT, engendering risks of misuse or over-reliance (Stanford, 2025, p. 9). The European Commission's *The Impact of Artificial*

Intelligence on Learning, Teaching, and Education (2018) further notes that ongoing professional development (PD) programs may not have AI-specific modules, highlighting a systemic policy lag across Europe and beyond (Tuomi et al., 2018, p. 34). Further, ethical oversight is not addressed properly, with the World Economic Forum's Artificial Intelligence for Children Toolkit (2022) alerting to exclusionary AI designs that disproportionately affect the vulnerable populations to unknown risks, an implication reverberating in diverse contexts like Latin America and Southeast Asia, where cultural biases in AI tools are not managed (WEF, 2022, p. 15). These gaps are attributable to fragmented international collaboration, insufficient funding for global PD initiatives, and the absence of education-specific regulations, necessitating a coordinated approach to bridge these disparities.

5.1.4 AI in Teacher Education: Global Insights

The integration of Artificial Intelligence (AI) into teacher education augurs a paradigm shift in preparing educators for future-ready classrooms, aligning with global frameworks that emphasize ethical, human-centered, and equitable AI adoption. Drawing from the analyzed case studies such as the EU's 2018 AI Strategy, Council of Europe's 2024 Preparatory Study, JRC's 2018 Report, OECD's 2023 Digital Education Outlook, UNESCO's Beijing Consensus (2019), AI and Education Guidance (2021), K-12 AI Curricula Mapping (2022), UNICEF's 2021 Policy Guidance, and WEF's 2022 AI for Children Toolkit this section explores AI's role in teacher education. These frameworks highlight AI's potential to enhance pedagogical breakthrough, inculcate AI literacy, and address socio-emotional impacts, while highlighting risks like biases and digital divides. For India, with its gigantic education system serving over 260 million students and facing acute teacher shortages (1:30 ratios), linguistic hyper diversity (22 official languages), and acute infrastructure gaps (35-40% rural digital divide), these insights

offer actionable items under the NEP 2020, which stresses technology-enabled teacher training and AI literacy (NEP 2020; IJERT, 2025). This analysis presents core benefits, lessons from experience, and recommendations tailored to India's context by ongoing initiatives like NISHTHA and DIKSHA.

5.1.5 Core Benefits for India

AI enables customized training modules that adapt to individual teacher needs, growing skills efficiently. For instance, the OECD's 2023 framework emphasizes "teacher AI literacy," targeting to upskill 2-3 million teachers globally by 2027 with real-time pedagogical feedback. This ameliorates administrative burdens by 20-30% and enhances efficiency in multilingual settings (OECD, 2023; EY, 2025). For us, AI can generate training that fits each teacher's needs, like customized lessons that adjust to how they learn the best. This can help programs like NISHTHA skill millions of teachers faster, optimizing time on formalities and rendering teaching more effective. Second, AI supports ethical AI literacy and critical thinking, as per UNESCO's 2021 Guidance and K-12 Mapping, which argues about integrating AI competencies early on; in India, AI can skills teachers about how to use it smartly, helping them explore these tools and avoid mistakes, like unfair grading, in diverse classrooms. This supports NEP's goal of better education and can improve student results. Third, AI can render training inclusive, stressing that teachers learn to help all students, even those with special needs like Divyang or no tech access, which is important for India's schools' hyper diverse infrastructure.

5.1.6 Lessons for India

The frameworks provide important directives for India's teacher education, cautioning against over-reliance on AI while emphasizing human agency, as echoed in the JRC's "next

electricity" analogy and Beijing Consensus's humanistic steering. An important lesson learnt is the need for evidence-based engagement with AI. The Council of Europe's risk-proportionate approach highlights the pitfalls of invalidated AI tools propagating biases (Council of Europe, 2024). For India, this underscores the importance of requiring independent audits before introducing AI systems in education. Such audits should guarantee that technology complements, rather than replaces teachers and is especially critical given the persistent shortage of well-trained educators. Early edtech pilots in India have sometimes left a lot to be desired to account for cultural nuances, risking the scaling of ineffective and obsolete practices (JRC, 2018). Under the National Education Policy (NEP), AI tools must be rigorously tested to align with the local contexts and reinforce teacher roles (Council of Europe, 2024) in a mixed initiative setup. The second key lesson is the importance of stakeholder synergy. Frameworks from the OECD and UNESCO stress inclusive ecosystems involving public-private partnerships, educators, and parents (OECD, 2023; UNESCO, 2019). India's challenges with teacher preparedness highlight the need for collaborative training models. Programs like NISHTHA must evolve to place AI as a supportive "co-pilot" rather than an autonomous replacement, ameliorating the deskilling of educators and incentivizing their active role in shaping AI integration (OECD, 2023). Third, Ethical considerations, drawn from the EU's AI strategy and UNICEF's guidelines, outline the importance of data privacy, particularly in diverse contexts (EU Strategy, 2018; UNICEF, 2021). India must look into potential privacy breaches in AI tools, such as video-based systems, to reduce amplifying biases related to caste, gender, or other demographic factors (UNICEF, 2021). Adopting GDPR-like standards can secure student and teacher data while fostering trust in AI applications (EU Strategy, 2018).

Finally, harmonized and seamless integration of AI literacy is essential to avoid fragmented adoption. Global examples, such as South Korea's inclusion of AI in school curricula

(National skills network, 2025), offer a working model for India to embed AI literacy in pre-service teacher training programs. This approach counters infrastructural challenges, particularly in rural areas, and ensures educators are equipped and trained appropriately to use AI effectively. A critical shortcoming to avoid is techno-solutionism, which risks widening educational divides without targeted investments in rural infrastructure and corresponding system upgrades (UNESCO, 2021).

5.1.7 Recommendations

To implement global insights for AI integration in teacher education, India should adapt international frameworks through the lens of the National Education Policy (NEP) 2020, focusing on state of the art scalable and equitable reforms. Following strategies align with global best practices while addressing India's peculiar educational context. First, design a national AI literacy curriculum for pre-service teachers, drawing on UNESCO's project-based pedagogies and OECD's Digi.kompP model (UNESCO, 2022; OECD, 2023). This curriculum should be mandated in B.Ed. programs under the National Council for Teacher Education (NCTE), expanding initiatives like NISHTHA to include ethical/moral audits that reduce biases in multilingual AI tools (UNESCO, 2022). Such modules will skill teachers to use AI responsibly while prioritizing cultural, social and linguistic diversity.

Second, inculcate public-private partnerships (PPPs) inspired by the Beijing Consensus and the World Economic Forum's FIRST framework (UNESCO, 2019; WEF, 2022). Collaboration with edtech firms can inspire the development of AI co-piloting tools customized for Indian classrooms, with pilots debuted in institutions overseen by the All-India Council for Technical Education (AICTE). These initiatives should incorporate child participation, as emphasized by UNICEF, to address developmental vulnerabilities, sensitivities, concerns and ensure

AI tools support student well-being (UNICEF, 2021). Third, prioritize investments in infrastructure and monitoring. Budget allocations should support offline AI models and enhanced connectivity in rural schools, addressing digital divides (IJERT, 2025). An AI ethics board, inspired by the Council of Europe, should be constituted to conduct ongoing evaluations, integrating JRC's socio-emotional research to measure the impacts like the erosion of teacher agency (JRC, 2018; Council of Europe, 2024). This ensures AI promotes, rather than undermines, educators' roles. Fourth, highlight evidence-based pilots through initiatives, adapting the EU's risk-based AI Act for high-stakes and sensitive contexts such as competitive exams (EU Strategy, 2018). These pilots should include teacher feedback loops to evolve AI tools, ensuring they align with classroom needs and improve learning outcomes (LPU, 2025). Such an approach moderates the scaling of untested technologies and inculcates educator trust. Finally, amalgamate with global standards by participating in platforms like UNESCO's Digital Learning Week (UNESCO, 2022). This enables cross-border learning, ensuring NEP's focus on 21st-century skills—such as critical thinking and ethics—upgrades teachers for future job transformations while maintaining human oversight to sustain trust (UNICEF India, 2025; Education for All in India, 2025). These steps will empower India's educators, aligning with NEP's vision for inclusive, innovative and futuristic teaching.

5.2 Current Global Trends (*Appendix B*)

Global trends show that countries are heavily prioritizing AI for education to achieve measurable improvements in learning outcomes, teacher efficiency, and digital literacy (***Please refer to Appendix B***). For example, the United States pumped $47.4B in private AI firms and $20M in public AI research, resulting in widespread adoption of K–12 adaptive platforms, AI chatbots in higher education, and improved student learning gains (*OECD,*

2021). Similarly, China's $10B+ EdTech VC investment and national pilot schools have empowered smart classrooms, AI grading, and AI curricula for over 500 universities, significantly enhancing engagement and learning efficiency (*UNESCO, 2021*). The UK, EU, and Australia have combined public endowments with strategic partnerships to deploy AI frameworks, adaptive tools, and teacher training programs that improve inclusion, cognitive learning outcomes, and administrative efficiency (*Council of Europe, 2024; UNICEF, 2021*).

For India, funding in AI is growing rapidly, including $3B in EdTech startups, NITI Aayog's NSAI pilot programs, DIKSHA AI integration, and global collaborations with IBM, Intel, and Microsoft. These funds have already yielded notable achievements, such as the CBSE AI curriculum for Grades 8–10, training of over 1 million students through Intel's AI For All, Mindspark's 2–4 months learning gains, and Byju's reach to 150M+ students (*Ministry of Education, 2020; NITI Aayog, 2018*). Learning from global examples, India can strategically leverage funds to facilitate AI access, enhance personalized learning, manage teacher workload, and lift AI literacy, while guaranteeing ethical, inclusive, and contextually relevant AI solutions for its diverse student population (*UNESCO, 2019; WEF, 2022*).

5.3. Country-Specific Initiatives

The integration of artificial intelligence (AI) into education systems worldwide represents a metamorphic shift, facilitating personalized learning, upgraded teacher training, and data-driven decision-making. Drawing from recent analyses and reports (2024–2025), this study demonstrates examples from eight countries: Singapore, China, South Korea, India, the United States, the United Kingdom, Japan, and Finland. Each case highlights a specific institution or program, its primary aims, key implementations, and supporting evidence from scholarly

and institutional sources. These examples illustrate how AI is being deployed to address educational challenges, from equity in access to modernized pedagogy, while emphasizing high ethical considerations and teacher empowerment.

1: Singapore – National Institute of Education (NIE) AI@NIE Initiative

The National Institute of Education (NIE) in Singapore, as part of the broader "Smart Nation" initiative, has pioneered the AI@NIE program to amalgamate AI into teacher education and classroom practices. The primary aim is to skill educators with AI literacy and tools to foster customized learning, mitigate administrative burdens, and prepare students for a technology-driven future. Key implementations include a five-year plan to train all pre-service and in-service teachers in AI applications by 2026, such as adaptive learning platforms for customized feedback and automated grading systems tailored to Divyang students with special needs. Collaborative efforts with research centers like AICET have introduced AI companions that provide real-time student motivation analytics, thereby enhancing engagement and outcomes for academic progress. As noted in a UNESCO report (2023), this approach aligns with Singapore's policy framework, which emphasizes EdTech amalgamation to create equitable, innovative active learning environments. Through pilot studies, NIE has demonstrated reduced teacher workload and improved lesson adaptability, setting a benchmark for AI-driven professional development for better.

2: China – Squirrel AI Learning Pilots in National AI Education Bases

In China, Squirrel AI Learning has been piloted across 184 designated national AI education bases, including schools in Beijing and Shanghai, under the Ministry of Education's

guidance. The program's aim is to address educational disparities, particularly between urban and rural areas, by delivering customized tutoring and enhancing standardized test performance through AI-driven adaptive systems. Key implementations involve facial recognition for attendance tracking in real time, data analytics for real-time lesson adjustments, and a national high school AI textbook introduced in 2018. The platform analyzes vast datasets to personalize Math and science curricula, resulting in up to 30% improvements in test scores. Teacher training incorporates AI dashboards for informed interventions, as evidenced by large-scale events like the Guinness World Record-breaking online math class in 2024 involving over 112,000 students. This initiative reflects China's grand experiment in AI education, which could reshape global learning models by prioritizing scalability, accessibility and equity.

3: South Korea – Korea Education and Research Information Service (KERIS) AI Education Research Schools

South Korea's KERIS has established 350 AI Education Research Schools to pilot ground breaking digital tools nationwide. The aim is to create an online-offline convergence system that fosters creative global talent, with a focus on customized teacher professional development and student AI literacy. Implementations include adaptive platforms like Riiid (Right Information and Intelligence Distribution) for personalized homework in subjects such as English and math, and EDUNET's AI analytics for engagement tracking. Since 2021, AI electives in high schools and model classrooms at the Future of Education Center have trained educators on ethical/moral integration. A qualitative study highlights how these efforts augment teacher competencies in AI curricula, particularly for elementary levels. Despite initial plans for mandatory AI textbooks in 2025 being scaled back, KERIS's

blueprint continues to influence global AI education strategies by emphasizing comprehensive teacher support.

4: United States – Georgia Institute of Technology's Jill Watson AI Teaching Assistant

At Georgia Tech, the Jill Watson AI Teaching Assistant, developed by the Design Intelligence Lab, has been integrated into the Online Master of Science in Computer Science program since 2016. The aim is to scale educational support for large cohorts, reduce instructor workload, and inform AI ethics in teacher education in an scalable fashion. Implementations include Watson-powered virtual TAs that handle 97% of forum queries accurately, predicting at-risk students with 80% precision for interventions. By 2025, enhanced with ChatGPT, Jill has outperformed generic models in real classrooms, boosting teaching presence in online settings with some confidence. This case underscores AI's role in accessible higher education, as per U.S. Department of Education insights on future learning.

5: United Kingdom – Century Tech Platform in Harris Federation Schools

Century Tech's AI platform is utilized in over 1,200 UK schools, including those in the Harris Federation, to personalize K-12 education. The aim is to empower teachers with data insights, minimize planning time, and ensure equitable learning outcomes under the Department for Education's 2023 AI safety framework. Key implementations involve adaptive lessons in math and English, real-time analytics for adjustments, and AI for quiz creation at Oak National Academy. This has cut teacher preparation by 30%, with hackathons enhancing curriculum adaptation. As an award-winning tool, Century Tech exemplifies AI's transformative potential in further education.

6: Japan – Keio University's AI and Advanced Programming Consortium (AIC)

Keio University launched the AIC in 2019 to cultivate AI expertise among undergraduates. The aim is to address ethical AI use, detect misuse in assessments, and prepare students for a tech-centric society through student-led communities in a scalable fashion. Implementations include generative AI prompting courses that flag cheating via off-topic outputs, and national systems like LEAF for personalized learning in special needs education. 2023 guidelines have piloted AI analytics in select institutions. Partnerships with Carnegie Mellon University further advance AI research, reflecting Japan's emphasis on global collaboration.

7: Finland – ViLLE Platform in National Schools

The ViLLE (2020) platform, developed by the University of Turku's Centre for Learning Analytics, is used in approximately 50% of Finnish schools. Its aim is to provide equitable, data-informed education through immediate feedback and analytics, promoting student wellness and ethical AI integration towards academic progress. Key implementations include AI tools for math and programming assignments, with the AI in Learning project testing systems for holistic performance. Awarded UNESCO's ICT in Education Prize in 2021, ViLLE enhances teacher training via national guidelines. This initiative highlights Finland's focus on collaborative, inclusive AI adoption.

8: Yuanfudao (Ape Tutoring)

Yuanfudao, a Beijing-based EdTech unicorn founded in 2012 by Li Yong and ex-tech executives, has grown into a leader in China's online education, backed by Tencent and Hillhouse Capital, with a strong AI focus. Serving millions of K-12

students via its app, it offers free examination practice and aims to democratize education through AI-driven personalized learning, homework help, and examination preparation for subjects like Mathematics and English. Key features include AI tutoring with photo uploads using semantic analysis and tag matching, adaptive learning paths based on behavior data (e.g., time spent, error rates), and a tagged question database for tailored reports, all enhanced by continuous tech innovation. Challenges include regulatory shifts from the 2021 "double reduction" policy, data privacy concerns, and market competition, pushing a pivot to hardware and AI scaling while maintaining educational quality.

9: Zuoyebang (Homework Help)

Zuoyebang, a 2015 Baidu spin-off founded in Beijing, has evolved into a major EdTech platform with $2.94 billion from investors like Alibaba and Sequoia Capital, leveraging AI tools for K-12 education in China, boasting over 300 million questions. Aimed at adolescents for examination preparation in mathematics, languages, and sciences, it provides accessible homework help and personalized learning using big data and algorithms, supported by a robust tech scalable infrastructure. Key features include AI tutoring with photo-based image recognition, adaptive courses analyzing user cognitive errors and behaviors, and a tagged question database for customized reports, with ongoing updates to improve user experience.

These international case studies offer valuable lessons for India, where AI can address persistent challenges like educational inequities and high dropout rates. By adapting personalized tools from models like Squirrel AI or ViLLE, and scaling teacher training akin to NIE or KERIS, India could enhance its CBSE pilots, fostering inclusive growth and aligning with national AI strategies to empower millions of students across the country.

5.4 AI Policies and Reports in India

The following key policies and national reports provide the strategic foundation for India's approach to integrating Artificial Intelligence in education, with particular implications for teacher education and professional development.

5.4.1. National Strategy for Artificial Intelligence (NITI Aayog, 2018)

The National Strategy for Artificial Intelligence (*NITI Aayog, 2018*) represents India's foundational policy vision for AI adoption, framed under the principle of "*AI for All*." The strategy positions AI as a metamorphic tool to address structural challenges related to access, affordability, quality, and resource shortages, particularly in socially critical sectors such as education.

The strategy for the education and teacher education ecosystem emphasizes leveraging AI to enhance and empower human capabilities, enabling teachers to address diverse learning needs including the same of Divyangs' and classroom challenges. It focuses on enabling access and quality of education through AI-driven customized learning, adaptive content, and data-supported decision-making. Additionally, it highlights the importance of developing scalable AI solutions suited for emerging economies and India's large but hyper diverse school system, while identifying high-impact AI applications in education to support innovation and systemic improvement. The strategy also promotes research and a vibrant national AI ecosystem through collaboration across government, academia, and industry and underscores the need for establishing guidelines for responsible AI, underscoring the ethical/moral, safe, and transparent use of AI tools in schools and teacher preparation programmes.

5.4.2. Artificial Intelligence Integration for School Curriculum, CBSE (2019)

The *CBSE Artificial Intelligence Integration for School Curriculum (2019)* represents one of India's earliest system-level efforts to embed AI awareness and literacy within school education. Developed in response to the profound transformations, the document outlines a structured approach to preparing both learners and teachers for an AI-enabled future, and introducing across social, economic, technological and educational domains. The framework addresses two interrelated dimensions: the need for students to understand AI as an everyday technology influencing all aspects of life, and the need for teachers to engage with AI as a cognitive-science-driven discipline that supports deeper learning processes in a scalable fashion.

Initiative 1: AI as a Ubiquitous Technology

AI influences communication, transportation, healthcare, manufacturing, defense, and digital services. CBSE (2019) therefore emphasizes developing students' AI awareness to support personal growth, future employability, and informed digital citizenship.

Initiative 2: AI as a Cognitive Discipline

The framework positions AI as a field that builds intelligent systems, requiring teachers to develop AI literacy and adopt student-centered, technology-enabled practices. It provides training guidelines for teachers (Classes 6–10), viz., AI glossary, AI tools, and App Matrix to support curriculum integration in an accessible fashion.

Following are the key components

1. Curriculum Redesign (What to Teach) focuses on prioritizing transferable skills such as critical thinking and adaptability,

integrating emerging themes like AI ethics and sustainability, and updating content to emphasize core concepts and real-world applications.

2. Pedagogical Enhancement (How to Teach) includes using AI-based adaptive tools for personalized learning, supporting collaborative and continuous assessment through AI systems, and providing AI-enabled teacher support for workload reduction, students well-being management and data-driven planning.

3. Ethical Governance involves auditing AI tools for fairness and privacy protection, promoting evidence-based adoption through research and validation, and ensuring equity by building teacher AI literacy and enabling access across schools with diverse infrastructure.

5.4.3. National Education Policy 2020

The *National Education Policy (NEP) 2020* provides a comprehensive vision for integrating technology and emerging disciplines particularly artificial intelligence into India's education system. The policy emphasizes building a sustainable digital education ecosystem and strengthening national capacity in AI through curriculum reform, professional preparation, and expanded research opportunities across various disciplines. Following are the key directions which includes develop curricula and pedagogy to introduce new subjects like AI and Design Thinking to develop important skills in students at all levels, to prepare professionals adept in cutting-edge technologies like AI, to offer postgraduate and doctorate programmes in AI/ML to offer targeted training in low-expertise tasks that support the AI value chain, such as data annotation, image classification, and speech transcription, to use NLP to translate textbooks into all Indian languages, and to establish a National Research Foundation (NRF) (later renamed as Anusandhan National Research Foundation (ANRF)) with advancing core AI research as one of its objectives along with killer applications.

5.4.4. National Digital Education Architecture (NDEAR), 2021

The *National Digital Education Architecture (2021)* provides a unified framework of principles and digital infrastructure to support the NEP 2020 vision by enabling interoperable, scalable, and learner-centric digital innovative solutions across India's education ecosystem. It establishes a foundational architecture to meet the needs of learners, teachers, and administrators through coordinated, open, and reusable technology systems. Key features include:

- Enable personalized learning by leveraging AI/ML algorithms
- Enable data collection in schools through modern AI tools
- Focus on speech detection and analysis services for learning languages using AI/ML speech processing
- Focus on customized learning assistant solutions to help all students including Divyangs learn at their own pace by leveraging AI/ML
- Develop a set of reusable AI services, open source training data, open-source libraries, open-source models and datasets for the education domain that can be leveraged and embedded within other building blocks

5.4.5. Responsible AI. Approach Document for India. Part 1 – Principles for Responsible AI (NITI Aayog, 2021a)

The Responsible AI Approach Document (NITI Aayog, 2021a) offers a structured national framework for understanding how Artificial Intelligence should be designed, developed, deployed, and governed across sectors, including education. It views AI not merely as a technological innovation but as a socio-technical

system that interacts with people, influences decisions, and shapes institutional and societal outcomes. Consequently, the document emphasizes that AI systems must function in ways that are safe, fair, transparent, and sensitive to India's social and cultural diversity and traditions. The overarching aim of the framework is to ensure that India's expanding use of AI remains aligned with national values, democratic principles, and the constitutional commitment to equity and inclusion. To guide responsible AI adoption, the document outlines seven foundational principles: 1. Safety and reliability 2. Equality 3. Inclusivity and non-discrimination 4. Privacy and security 5. Transparency 6. Accountability 7. Protection and reinforcement of positive human values

5.4.6. Responsible AI. Approach Document for India. Part 2 – Operationalizing Principles for Responsible AI (NITI Aayog, 2021b)

The *Responsible AI (Part 2)* document (NITI Aayog, 2021b) explains how India can put its ethical AI principles into practice. While Part 1 describes what Responsible AI means, Part 2 focuses on how these ideas can be implemented across different sectors, including education. Its main aim is to build systems that make AI safe, fair, transparent, accountable, and human-centric. It also emphasizes that the responsibility for ethical AI should be shared among the government, private sector, and society. To achieve this, the document proposes three key measures:

- Establish a multidisciplinary advisory body, such as a Council for Ethics and Technology, to formulate AI policies and act as a think tank for the development of quality research products related to AI as well as testing of AI products.
- Private sector to ensure cost-effective compliance with AI standards and commensurate hardware platforms.

- The government to establish awareness, accessibility, and capacity-building, develop regulatory and policy measures, and support accurate procurement methods for AI and related infrastructure.

These hold huge promise but come with risks, especially for kids, who need extra protection due to their growth and rights (Council of Europe, 2024, pp. 9, 13).

5.4.7 Development of the National Artificial Intelligence Resource Platform (NAIRP) *(MeitY, GoI – Committee A)*

The NAIRP aims to create an open and collaborative AI ecosystem by integrating datasets, tools, research, and best practices into a unified national platform. It seeks to strengthen capacity-building, drive innovation, and support socio-economic development through shared digital resources. Key strategies of the committee include developing a contributory platform, establishing a centralized AI repository, enabling partnerships for data sharing and standards, supporting training and start-ups, leveraging existing infrastructures such as NDLI and data.gov.in, and building the platform through a government-funded project led by premier institutions across multiple domains.

5.4.8 National Missions in Key Sectors *(MeitY, GoI – Committee B)*

This committee focuses on leveraging AI's metamorphic potential by identifying priority sectors and defining national AI missions. It aims to stimulate innovation, student engagement, and technology transfer to address real-world challenges. Core strategies of the committee include identifying approximately 20 sectors, including agriculture, food, water, environment, education, transportation, legal, finance, and governance. Its

responsibilities include designing sector-specific road-maps, organizing national AI contests with curated datasets, integrating ministerial data on common platforms, and enabling start-ups, open-source solutions, and cross-sector collaborations.

5.4.9 Policy Enablers, Skilling, and R&D for AI Adoption *(MeitY, GoI – Committee C)*

The goal of this committee is to create a supportive regulatory and policy environment that accelerates AI adoption across sectors. It emphasizes the need for accessible public data, enabling regulations, collaborative experimentation, and targeted skilling across multiple sectors. Committee strategies include removing regulatory barriers, enabling Proof of Concepts (POCs) with government support, scaling successful pilots, mapping national technological capabilities, and promoting skilling and re-skilling for effective AI deployment in a scalable fashion.

5.4.10 Cybersecurity, Safety, Legal and Ethical Issues in AI *(MeitY, GoI – Committee D)*

This committee aims to ensure that AI and machine learning technologies are responsibly developed and applied, balancing innovation with safeguards that protect users, maintain fairness, promote trust, enable cross-border data sharing, and foster data-driven governance, user friendly interface for text/visual data presentation and ethical practices. Its key recommendations include context-driven accountability frameworks, regular regulatory reviews, flexible self-regulation, liability models, stakeholder engagement, and strengthening AI governance, research, and capacity-building.

5.5. Indian Case Studies and Best Practices

India's public education system grapples with challenges like teacher shortages, large class sizes, and low foundational literacy

and numeracy (FLN) rates, with 50% of Grade 5 students unable to read Grade 2 texts (ASER Centre, 2023). The National Education Policy (NEP) 2020 emphasizes technology to achieve equitable, skill-based learning to facilitate employability. Three pioneering AI-driven initiatives—FLN-AXL, UTSAV 2025, and Shiksha Copilot—exemplify this transformation. FLN-AXL (Telangana/Karnataka) enhances FLN for remedial learners through adaptive language/math tools. UTSAV 2025 (Uttar Pradesh) fosters 21st-century skills like coding via AI chatbots. Shiksha Copilot (Karnataka) empowers teachers with rapid, curriculum-aligned lesson planning. A short comparison of the three projects is tabulated below:

Aspect	**FLN-AXL**	**UTSAV 2025**	**Shiksha Copilot**
Background	Launched to address NEP 2020's FLN goals amid teacher shortages and 50% Grade 5 reading gaps (ASER, 2023). Developed by EkStep Foundation as Directorate of Public Instruction (DPI) for remedial learning in Telangana/ Karnataka government schools.	Initiated to align with NEP 2020 and IndiaAI Mission, tackling skill gaps in Uttar Pradesh's 200M+ population. Led by TAP, UP government, and Microsoft India for experiential learning.	Designed to reduce teacher workload in Karnataka's low-resource schools, supporting NEP 2020's tech integration. A Microsoft Research-Sikshana Foundation collaboration under Project VeLLM.

Aim	Enhance FLN for remedial learners via adaptive AI for language/ math, creating judgment-free learning environments.	Foster 21st-century skills (coding, STEM, financial literacy) through AI-driven, personalized experiential projects.	Empower teachers with AI-generated lesson plans/ assessments to promote activity-based pedagogy and efficiency.
Scope	Telangana: Pilot (Feb–Mar 2025, 41 schools); expanded to 5,000+ schools by Jun 2025. Karnataka: Phase I (Nov 2024–Mar 2025, 100 schools); Phase II (Apr 2025–Mar 2026, 2,000 schools, ~200,000 students). ₹56 crore invested.	Launched May 3, 2025, in Lucknow/ Varanasi, impacting 10,000+ students. Scaling to 150,000 students, 5,000 teachers across 17 UP districts in 2025–26.	Piloted Oct–Dec 2024 in 10+ Bengaluru schools; deployed to 1,000+ teachers statewide by Mar 2025, evaluated through Jul 2025.
Target Group	Primary/upper-primary students (Classes III–X) in Telangana/ Karnataka, especially slow learners/ dropouts. District coordinators trained.	Secondary students (Grades 9–12) in UP government schools, urban/ semi-urban focus. Teachers trained for AI integration.	Government school teachers (Grades 4–8) in Karnataka, using English/ Kannada. 1,043 teachers, 23 curators engaged.

Takeaways for Nation	1. Scale DPI for FLN goals, targeting 7 lakh+ students. 2. Conduct mixed-methods evaluations for impact. 3. Align with IndiaAI Mission for skill ecosystems. 4. Invest ₹8,000+ crore in AI labs and ethics.	1. Build national 21st-century skill frameworks. 2. Mandate data sovereignty in AI tools. 3. Link to AI City initiatives (e.g., UP's ₹10,700 crore). 4. Promote interstate benchmarking.	1. Model scalable teacher copilots for diverse sectors. 2. Prioritize longitudinal studies for pedagogy shifts. 3. Address staffing shortages systemically. 4. Foster equitable EdTech under NEP 2020.

Developed through public-NGO-tech partnerships (EkStep Foundation, The Apprentice Project, Microsoft, Sikshana Foundation), these programs, launched in 2024–2025, offer scalable models for India's education reform.

This part of thework has examined the evolving landscape of Artificial Intelligence (AI) in education, highlighting national policies, Indian case studies, global frameworks, and best practices. Analysis of AI initiatives in India, such as the CBSE AI curriculum, NITI Aayog pilots, and EdTech interventions, demonstrates the potential of AI to enhance personalized learning, support teachers, and bridge educational gaps. Comparative insights from global frameworks and country-specific case studies underscore the importance of ethical deployment, regulatory oversight, stakeholder engagement, and capacity-building. Further, global lessons emphasize the need for contextually relevant AI solutions, inclusive access, and professional development for teachers, while aligning with national priorities such as the National Education Policy 2020. Moving forward,

strategic investments, multi-stakeholder collaboration, and a strong regulatory framework will be critical to realize the benefits of AI in education at scale, ensuring equitable, efficient, and ethical learning outcomes for all students.

6

Policy landscape for Building an AI Ecosystem in Education: Perspectives and Recommendations

The integration of artificial intelligence into India's education system requires not only technological readiness but a comprehensive policy, regulatory framework, and ecosystem-driven approach, in line with the National Education Policy (NEP) 2020, which emphasizes learner diversity, teacher empowerment, and meaningful technology integration. This section outlines institutional roles, emerging frameworks, and actionable recommendations for future developments in AI-enabled education and teacher education.

6.1 AI Teacher Education Framework

Global frameworks underscore AI's transformative benefits for teacher education, as envisioned in NEP 2020's focusing on digital infrastructure and skill-building. The preparation of teachers is critically important as they will be torch bearers and play a major role in implementation of these initiatives. India's evolving AI Teacher Education Framework seeks to embed AI

literacy, ethical awareness, and practical AI-enabled pedagogy within both pre-service and in-service teacher preparation. The framework emphasizes governance alignment with NEP 2020, operational readiness (infrastructure, capacity building, partnerships), and pedagogical integration (AI in curriculum design, assessment, and student support). It can make training related to AI more inclusive, ensuring teachers readiness to facilitate all students, including those with special needs and lack of access to technology, which is important for India's diverse schooling landscape. The vision is to prepare educators not simply as users of AI tools but as co-designers and informed decision-makers in technology-mediated learning ecosystems.

A teacher education framework for AI is envisioned here, suggesting the development of an interconnected ecosystem of stakeholders. The technological advancements of AI influencing the classroom pedagogy as well individual learning is discussed in the following framework. This framework creates a holistic integration of AI across different facets of education. The effort is to distribute the responsibilities among different organisations for spearheading curriculum design, developing pedagogical and assessment models.

There is a need to generate synergy among teachers, education institutions, leaders at different levels, policy makers and other stakeholders. By synchronizing the efforts from different stakeholders, we can empower teachers to lead an AI-driven ecosystem effectively, ultimately fostering a generation of students to critically engage with technology, and become empowered citizens.

6.1.1 Regulatory Dimension of the Framework: Roles of Key Bodies

The aforementioned discussion toward an AI teacher education framework now elucidates the regulatory aspects of all the key bodies that need to be in place for effective implementation of

AI in education. A schematic description delineating the overall framework is illustrated in Figure 3.

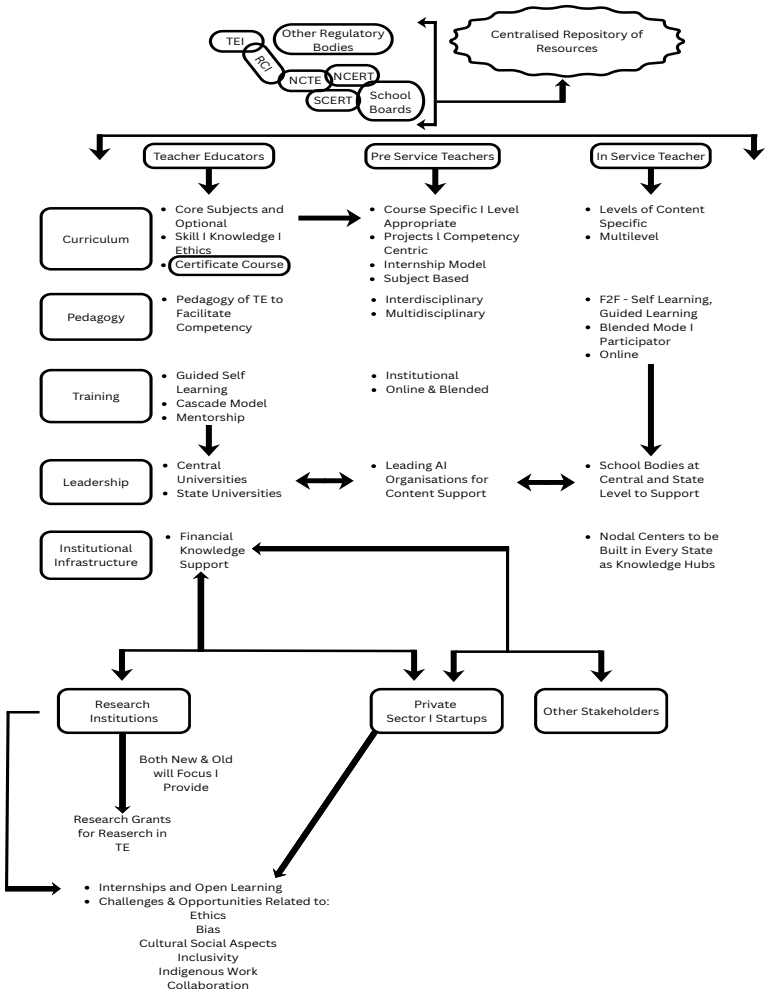


Figure 3: AI teacher education framework

Different organisations and institutions need to work under the leadership of the Ministry of Education for the effective implementation of AI in education. Collaboration among the stakeholders is critical for the evolution of a unified but flexible

approach towards implementation of AI in education. The present framework focuses on implementation of AI in school education mainly by developing AI competency of teachers. All regulatory bodies and stakeholders, including the National Council for Teacher Education (NCTE), National Council of Educational Research and Training (NCERT), State Councils of Educational Research and Training (SCERT), Rehabilitation Council of India (RCI), Regional Institutes of Education (RIE), and state boards, must coordinate to establish a strong foundation for the adoption of AI in teacher education. A unified framework is essential, ensuring that standards for curriculum, ethical deployment, and data privacy are consistent at all the levels. Although flexibility in terms of usage should be at the core. The stakeholders should work to build a centralised repository of resources, which would function as a national digital platform for pedagogy. This repository should be a dynamic, curated, and vetted ecosystem. It should include not only AI-driven content, templates, modules, videos, and tools but also validated case studies, best-practice frameworks, and pre-trained AI models for educational use. This management of resources is vital for quality control, preventing the duplication of effort across states and ensuring that even the most remote and poorly-funded institutions have access to high-quality resources. Effort should be made to give a platform to the indigenous developers who are certified. Furthermore, this repository must be built on interoperable standards to facilitate seamless development, access, and sharing of educational materials among all stakeholders. In terms of teacher education, the framework needs to adopt a three-pronged approach, catering to teacher educators, pre-service teachers and in-service teachers. The core elements should focus on curriculum, pedagogy, training, leadership, and institutional infrastructure. Focus should be on updating the curriculum to incorporate both core and optional subjects that emphasise AI literacy and digital competencies. There is a need to propose the adoption of advanced AI tools for skill development, contextual learning,

and pedagogical transformation. The role of teacher educators will increasingly involve guiding future teachers in AI-facilitated competency acquisition, supporting self-learning, and providing mentorship through AI-powered platforms. Programs and training models should leverage AI for a cascade model of mentoring, continuous evaluation, and personalised feedback mechanisms.

Pre-service teachers must be exposed to experiences with curricula that incorporate AI-driven modules and projects, which are commensurate with the subject and the grade. AI technologies have the power to enable interdisciplinary and multidisciplinary approaches, support subject-based and competency-driven models, and facilitate both institutional and blended learning environments. Pre-service teachers will also benefit from AI-powered organisational content support, ensuring that learning pathways are dynamic and adaptive to individual needs. For in-service teachers, AI adoption means access to need-based and multi-level training programs delivered through self-learning, guided facilitation, and participatory online and blended modes. AI platforms must be developed to support school bodies at both the central and state levels through targeted digital professional development resources and the establishment of nodal centres in every state to serve as AI-powered knowledge hubs. These nodal centres can be developed in collaboration with central centres for excellence.

Institutions of eminence and central universities should take the lead in AI adoption and ensure the development of robust institutional infrastructure, with a particular focus on financial and knowledge-based AI support systems. Research funding agencies should focus on innovation by providing research grants for AI-related exploration in teacher education. The private sector, start-ups, and other stakeholders should be encouraged to contribute by offering internships and open learning opportunities, many of which are enabled or enhanced by AI tools and platforms. Collaboration across these sectors will address challenges and opportunities in areas such as ethics, algorithmic bias, linguistic

diversity, cultural and social inclusion, support for indigenous knowledge systems, and cross-sector partnerships, all within the context of responsible AI use in teachers' education. It is difficult for a single stakeholder to possess the comprehensive perspective required to navigate these multifaceted issues effectively. Therefore, the integrated approach is essential to combine the expertise with the crucial pedagogical insight and the lived experiences of the diverse population. Together, these stakeholders can proactively embed principles of fairness and equity into AI tools from the genesis. This synergy can act to ensure that artificial intelligence serves as a genuine force for empowering teachers and creating more inclusive and effective learning environments for all. In the following sections roles of different stakeholders are detailed.

6.1.2 Recommendations for Stakeholders

As of October 2025, the Ministry of Education (MoE) maintains a forward-looking stance on AI in education, positioning it as central authority to improve teaching, learning, assessment, and administration. Anchored in the digital innovation agenda of NEP 2020, the MoE has adopted several large-scale initiatives like establishment of Centres of Excellence (CoE) in AI for Education. These are supported by a ₹500 crore allocation in the Union Budget 2025–26. The proposed CoE aims to drive research, innovation, interdisciplinary curricula (ML, robotics, data science, AI ethics), and partnerships with IITs, IIITs, and industry. There should be streams of government supported education programs where technical institutes, CoEs, development and implementation groups from industries can work in tandem to provide analytical and programmatic side of AI education training. AI-driven learning, evaluation, and content development will be linked with platforms such as SWAYAM and the National Digital University. AI Fellows Program will be launched to offer mentorship, stipends, and innovation

opportunities to students and young researchers working on AI in education. Early Introduction of AI in Schools as envisioned in NEP, 2020 has been initiated. Beginning 2026–27, the CBSE will roll out AI foundations from Class 3 onwards, supported by age-appropriate curriculum frameworks.

Implementation of AI in education will help in moving away from a one size fits all approach to more personalised and customized education that is contextual also. Implementation of OBE will be more effective with a more organised approach towards utilization of AI developments. Achievement of AI literacy among the stakeholders is critical not just to understand the issues and possibilities related to AI but also in harnessing its potential for individual, social and national growth. The developments of AI are critical for addressing the diversity at different levels and creating opportunities for all. For teachers it will reduce the administrative and planning burden at different levels and strengthen the pedagogical insights. If the government is able to centrally strengthen and implement the AI infrastructure and training for education, it can be a huge push for equitable resource allocation as well as developing a future ready society.

To harness the AI potential responsibly and equitably, a deliberate, structured, and ethically-grounded national strategy is imperative. The following recommendations are formulated to support the Ministry of Education in establishing a leadership position in the safe and effective integration of AI, ensuring it serves as a catalyst for pedagogical enhancement and systemic efficiency while safeguarding the fundamental rights and welfare of all stakeholders.

1. Centralized Policy Leadership and Systemic Integration

The Ministry of Education should promulgate a comprehensive, high-level national policy that establishes a clear, reliable, and principled framework for AI adoption. This policy should

advocate for systemic AI integration, wherein technological deployment is inextricably linked to curricular objectives and pedagogical practices, rather than being treated as a peripheral tool. A phased implementation approach is advised, commencing with leveraging AI for administrative efficiency before progressing to more complex applications such as personalized learning pathways. Central to this policy is the formalization of AI in teacher education. As the primary mediators of classroom technology, educators require robust professional development. Mandatory AI literacy modules in teacher training curricula should therefore focus not only on tool operation but, more critically, on the pedagogical implications of AI-driven insights.

Recommendations:

- Promulgate a National Policy on AI in Education (NPAI-Ed) that provides a unified vision and standards for all states and union territories. NCTE may take lead and propose policy for implementation of AI at different levels.
- Mandate the inclusion of AI Pedagogy and Ethics as a core component in all pre-service and in-service teacher education programs under the National Council for Teacher Education (NCTE) guidelines. NCTE may propose curriculum frameworks for different courses of education like the Integrated Teacher Education Programme (ITEP). Different courses should include the components of AI implementation in education. Students and teachers should be educated with AI tools for improving teaching-learning-assessment processes and enhancing student learning outcomes. The courses should aim to introduce the student-teachers to the importance of cutting-edge areas such as artificial intelligence, big data analytics, machine learning, etc. in the field of education. The pedagogical content knowledge needs to be reviewed

with the impetus of AI in education at different levels. The impact of AI at different levels need to be studied and discussed extensively for their integration in different courses of pedagogy.

- Teacher education institutions at different levels must ensure that different courses are aligned to address the challenges and possibilities. Curriculum alignment of different teacher education courses to train the teacher education students at different levels needs to be done to nurture critical skills for AI at different levels of schooling.
- AI competencies should be directly integrated into existing school curricula rather than treating it as an isolated subject. AI should be promoted as an integrated subject across various disciplines (as demonstrated by the CBSE) to enhance overall teaching and learning processes.
- NCTE should spearhead a transformative approach to embedding Artificial Intelligence and Computational Thinking (AI and CT) as foundational skills. NCERT should lead the creation of a spiral, grade-specific curriculum that progresses from basic digital literacy and ethical AI awareness in foundational stages (Grades 3-5) to applied computational thinking and problem-solving in middle school (Grades 6-8), culminating in introductory data literacy and AI for social good projects in secondary school (Grades 9-12).
- School Boards should provide schools with a standard acceptable use policy template to ensure uniform governance across institutions that currently lack clear guidelines.
- Implement a phased rollout strategy, initiating AI integration in school management systems (e.g., attendance, resource allocation) to build institutional

capacity before introducing classroom-focused AI applications.

2. Data Protection, Sovereignty, and Ethical Governance

In AI-assisted learning environments, student data becomes a profound reflection of cognitive and emotional development. Protecting this data is paramount. While the Digital Personal Data Protection (DPDP) Act 2023 provides a foundation, the education sector requires specific supplementation. A critical consideration is the Right to be Forgotten[1], particularly as it pertains to the retraction of data from AI model training sets to prevent perpetual digital profiling.

Recommendations:

- Institute a *National Ethics Board for Data and AI Safety in Education*, composed of multidisciplinary experts to conduct pre-deployment audits of AI systems for bias (e.g., against gender, caste, region, socio-economic status, or disability) and to establish security protocols to address concerns such as AI-facilitated deepfakes or unfair automated proctoring.
- Academic integrity should be clearly defined in the age of AI, specifically addressing issues like plagiarism and the generation of deepfakes. Clear and enforceable consequences for the unethical use of AI tools by students or staff.
- Formulate a sector-specific educational Data Protection Code under the DPDP Act, detailing protocols for the collection, storage, processing, and deletion of student data.

[1] https://gdpr.eu/right-to-be-forgotten/

- Legally obligate all educational AI providers to implement clear, accessible mechanisms for students and parents to retract consent and request data deletion, including its extraction from model training pipelines, thereby safeguarding the data sovereignty of the minor.

3. Regulatory Framework for Third-Party AI Tools and AI Safety

The current educational technology landscape features numerous third-party tools, including LLMs, which, while potent, may pose challenges related to data provenance, cultural alignment, and operational transparency. A proactive regulatory stance is necessary to ensure these tools meet Indian educational standards. The primary regulatory focus must be on *AI Safety and Alignment*, ensuring that models deployed in educational contexts are purpose-built for such sensitive environments. This necessitates the establishment of clear criteria for external providers.

Recommendations:

- Establish a mandatory Educational AI Tool certification process, requiring third-party providers to demonstrate compliance with Indian curricular standards, cultural context, and data privacy laws.
- Mandate the development and use of Education-Grade APIs from providers, which should include enhanced content filtering, fact-checking capabilities, transparency in data usage, and the disabling of data-mining for commercial profiling.
- Require a minimum standard of model interpretability for any AI providing student recommendations, ensuring educators can understand the rationale behind AI-generated suggestions to maintain accountable, human-in-the-loop decision-making.

- School boards should rigorously vet third-party ed-tech tools before they are introduced to schools. They should give a mandate that schools only adopt software and tools that have been proven to protect student data strictly, ensuring privacy compliance.

4. Institutional Infrastructure and Indigenous Capacity Building

To prevent fragmentation and promote equitable access, centralized coordination of AI resources and infrastructure is essential. Leveraging existing national high-performance computing assets can democratize AI innovation and support the development of culturally and linguistically representative models.

Recommendations:

- Establish a Centralized Agency for AI in Education (CAAIE) to serve as the national repository for standards, and best practices, providing a modular framework for state-level adaptation.
- Expand the scope of the AIRAWAT initiative at C-DAC to create a *National Educational AI Cloud*, providing secure, subsidized access to high-performance computing resources for public educational institutions and researchers across the country.
- Launch a *National AI-Education Fund* to finance critical infrastructure, subsidize access for under-resourced schools, and support longitudinal research on the efficacy and impact of AI interventions in diverse Indian contexts.
- Well-equipped schools should be utilised as "hubs" that can share computer resources and infrastructure with nearby schools to maximize investment utility.
- Establish centralized, cloud-based "AI Sandboxes" that allow students to run AI models via basic browsers,

shifting the computational load to the cloud and reducing the need for high-end local hardware.

- Develop and distribute "AI Unplugged kits" that teach algorithmic thinking through physical games and logic exercises, ensuring AI literacy reaches regions with limited internet connectivity.

5. Comprehensive Capacity Building and AI Literacy

The successful integration of AI is contingent upon the readiness of all stakeholders. A continuous, structured capacity-building program is required, moving beyond one-time workshops to sustained professional development journeys. Teacher Education Institutions (TEIs) must prioritise the integration of AI in the existing curricula of teacher education programmes, such as Integrated Teacher Education (ITEP), Bachelor of Education (B.Ed.), and Master of Education (M.Ed.). This integration should align with the emphasis on technology-enabled and competency-based teacher training in NEP 2020. There should be an emphasis on incorporating AI-driven pedagogies into all programs. It should be varied as per the needs and the level of the teacher education programmes and in alignment with the school curricula. It should focus on both theoretical and practical components. The practical components should align with the internship component of these courses helping them incorporate the necessary skills.

Recommendations:

- Initiate a *National AI Literacy Mission* with distinct programs for researchers, teacher-educators, in-service teachers, and parents, emphasizing AI as a tool for professional augmentation and pedagogical support. The National Council for Teacher Education (NCTE) is set to pilot its Plan of Action for the implementation of the

National Professional Standards for Teachers (NPST) under the Project Approval Board (PAB) 2025–26. As part of this initiative, a hybrid proctoring system will be introduced to systematically map and assess teaching competencies in alignment with the National Professional Standards for Teachers (NPST).

- Integrate AI Literacy as a foundational pillar within the national curriculum from secondary level onwards, focusing on conceptual understanding, critical evaluation of AI outputs, digital citizenship, and the socio-economic implications of automation, rather than mere tool-specific training.
- Commission the design of a standardized, sustainable AI Literacy curriculum by the CAAIE, ensuring its focus on enduring concepts remains relevant amidst rapid technological evolution.
- Organize parent literacy webinars and industry mentorship programs to create a supportive ecosystem and demystify AI for the broader community.
- Organize regional, collaborative hackathons reframed to solve local community problems (e.g., water waste, traffic), allowing students to apply interdisciplinary knowledge.

6. Evidence-Based Implementation and Continuous Evaluation

Technological adoption requires rigorous evaluation to ensure resources are directed toward demonstrably effective interventions. The principle of outcomes-focused investment should guide all AI initiatives.

Recommendations:

- Mandate that any large-scale deployment of an AI educational tool be coupled with a robust, independently

reviewed effectiveness study, utilizing control groups to measure impact on defined learning outcomes and equity indicators.

- Initiate "Open-AI exams" as pilot programs to shift testing focus from content generation to the critical skills of critiquing, verifying, and improving AI outputs.
- Establish clear recalibration or sunset protocols for programs where empirical evidence does not indicate a significant improvement in educational objectives, thereby ensuring accountability and the efficient use of public funds.
- Foster public-private-academic partnerships to generate indigenous, anonymized datasets for research and development, ensuring future AI models are trained on data representative of India's linguistic and cultural diversity.

The integration of AI into the Indian education system is an epochal opportunity to solve the Iron Triangle of education: quality, scale and equity. However, this potential can be realised if the Ministry of Education moves with strategic intent. By regulating external AI tool providers, centralising governance through expert committees, and prioritising ethical grounding, India can create an AI-enabled education system that is safe, productive, and uniquely Indian.

- Empower Institutional Leadership: Train school principals and TEI leaders to become institutional and instructional leaders in the field of development of AI skills among students.
- Promote and conduct research in AI in education:AI in education needs to be well researched in Indian context with a mechanism to share and inform associated institutions. There is a lot of research at present that is being conducted in Universities and institutions having

education as a department but the research needs to be transformative in nature. Also, there is a need to develop collaborations among the other departments of the university for more informed interdisciplinary research in AI.

- Build Partnerships with Stakeholders: TEI of central universities can act as the nodal centres where the collaboration between schools, universities, and society at large is being conceived and executed.

NEP 2020 reconceptualizes teacher roles, emphasizing professionalization, competency-based preparation, and technology-enabled pedagogy. In response, NCTE has introduced major reforms including the four-year Integrated Teacher Education Programme (ITEP), National Common Entrance Test (NCET), National Professional Standards for Teachers (NPST) and the National Mission for Mentoring (NMM).

As per the recommendations of the National Education Policy (NEP 2020), the integration of technology in teacher education has been given due emphasis. In alignment with this, the Integrated Teacher Education Programme (ITEP) includes a dedicated course on ICT in Education under the Ability Enhancement and Value-Added Courses. The course aims to introduce the student-teachers to the importance of cutting-edge areas such as Artificial Intelligence (AI), big data analytics, machine learning, etc. in the field of education. Further, NMM (MITRA) can prove to be critical in developing a model of mentoring the teachers on AI in education. It can be crucial in preparing a large number of teachers with an already existing framework and its expansion can be explored at different levels. Domain 9 of NPST (PUSHTI) focuses on 'Technology Use and Integration in Education' emphasizing teachers' ability to effectively use digital and ICT tools in teaching-learning processes. It can be extended to AI in teacher education by including competencies related to using, adapting, and creating

AI-driven tools for personalized learning, assessment, and classroom management.

6.1 Rehabilitation Council of India (RCI)

Education for learners with disability (Divyang) is an extremely challenging endeavour handled by The Rehabilitation Council of India (RCI) which has provided personalized curriculum for each learning track and pupils pursuing these pathways. RCI does not have specific thematic courses along the lines of "AI education" in the typical sense, but it does integrate AI technology and assistive devices into its curricular programs. For instance, one RCI-approved course is the Diploma in Computer Education & Assistive Technology (Visual Impairment), which can be a foundational step in leveraging AI technology for special needs education and facilitating their academic well-being. RCI's role is to standardize and regulate training for professionals in special education, which increasingly employs AI-enabled digital tools and AI inspired assistive technologies. Artificial Intelligence (AI) systems analyse patterns, predict outcomes, and adapt academic delivery to individual needs, empowering educators to deliver more targeted and responsive interventions. Role of Artificial Intelligence in rehabilitation, focusing on its applications in personalized care, customized education, outcome prediction, and real-time performance monitoring.

RCI should should include assistive AI technology as a core component in some of its special education programs. The focus should be on using AI-enabled computer education to assist individuals with disabilities.RCI is responsible for regulating training programs in fields like clinical psychology, prosthetics and orthotics, and speech and hearing, with a view to incorporating AI technology in a standardized way. RCI should promotes inclusive education by ensuring that its training programs cover a range of disabilities and prepare professionals to use modern AI tools to support learning.

6.2 Responsible and Societal AI

The responsible and societal AI aspects for the NCTE, teacher education curricula for both K-12 and higher education must be restructured around a multidimensional sociotechnical framework. Actionable strategies include the integration of *Trustworthy AI* competencies into the Integrated Teacher Education Programme (ITEP) empowering educators to move beyond basic digital literacy toward a critical understanding of algorithmic transparency, accountability, and fairness. Curricular design should adopt a *pro-actively responsible approach*, shifting the focus from technical performance to the enhancement of human learning prerequisites such as cognitive, affective, and pedagogical to ensure that artificial intelligence in education interventions are socio-culturally congruent and efficacious. Furthermore, teacher training should incorporate the Social Responsibility Pyramid, which defines a hierarchy of functional, legal, ethical, and philanthropic responsibilities, encouraging teachers to act as "good AI citizens" who can mitigate risks such as algorithmic bias and cyberbullying. To operationalize this in practice, the NCTE should mandate the use of governance instruments like AI FactSheets and model cards, providing educators with the necessary documentation to exercise human agency and oversight over classroom technologies.

The responsible integration of generative AI in educational settings necessitates a robust sociotechnical framework that prioritizes academic integrity and the preservation of evaluative validity through a shift toward process-oriented inquiry (Monib et al., 2024). To ensure societal alignment, educators must exercise vigilant oversight regarding the provenance of AI-generated content, adopting process-based assessments as a necessary precaution to maintain the authenticity of scholarship and the legitimacy of authorship (Lund & Wang, 2023). Furthermore, the deployment of LLMs requires a critical commitment to algorithmic transparency and factual

rigor, ensuring that instructional materials remain culturally inclusive and free from structural inconsistencies or historical misrepresentations (Kasneci et al., 2023; UNESCO, 2023). From a systemic perspective, bridging the digital divide and fortifying cybersecurity frameworks are imperative to guarantee that the benefits of GenAI are distributed equitably without compromising data privacy (Ji et al., 2022, UNESCO, 2023). Ultimately, the transformational potential of these technologies is contingent upon comprehensive professional development that fosters teacher agency and digital proficiency, ensuring that human-centric ethical guardrails and technical safeguards remain at the core of a trustworthy educational ecosystem (Ayanwale et al., 2025).

By prioritizing human-centric values and robust ethical guardrails, these recommendations ensure that the next generation of teachers can lead the development of an AI-mediated educational ecosystem that fosters societal well-being and protects students from both technical and social harms. The private nature of educational data makes it compulsory for institutions to set up very strict policies for the protection of this data as well as seek permission from students and their families before collecting their data.

7

Conclusion

The integration of Artificial Intelligence (AI) into education, specifically teacher education, is imperative in today's era. This is not just a technological shift but a civilisational shift. This transition marks a change from a standardised environment to dynamic, adaptive, and deeply personalised learning environments. However, this transition is not a linear process. It is marked by but a complex socio-technical reconfiguration shaped by both policy and practice. The journey of the Indian education system from ancient times to the modern era reflects a continuous vision where learners remain at the center, with teachers facilitating holistic development. This vision has been reinforced by the mandate of the National Education Policy (NEP), 2020. AI intends to supplement this process and help realise the vision of an equitable education system. This requires a coordinated effort from all stakeholders. This coordination must recognise that the transition to an AI-integrated ecosystem is not merely about digitising existing pedagogies but fundamentally restructuring the architecture of knowledge transmission. We are moving away from the industrial model of education, characterised by batch processing and standardised testing, toward a networked, intelligent ecosystem. In this new paradigm, the school is no longer a physical silo of information but a node in a vast, interconnected digital learning grid. The integration of AI

necessitates a four-layered preparedness framework comprising national digital infrastructure, school-level readiness, teacher capacity building, and student adaptability. Without this systemic alignment, the introduction of AI risks becoming a superficial add-on rather than a transformative force.

Earlier, the use of AI focused on increasing efficiency, such as automating administrative tasks, digitising textbooks, and streamlining grading. But, with the emergence of Generative AI (GenAI) and Large Language Models (LLMs), there is a shift towards augmentation. The role of AI has evolved from a tool to a collaborative partner. The "AI as Tutor" model is paving the way to "AI as Socratic Teammate". The technology does not merely provide answers but acts as a catalyst for inquiry, prompting students to question assumptions and refine their reasoning. This shift demands a reimagining of the pedagogical aspects. The "Post-AI" era requires educators to utilise these tools to foster higher-order cognitive skills, with a focus on creativity, critical thinking, and problem-solving. However, there must not be an over-reliance on AI-generated outputs, which can lead to a superficial engagement with knowledge. Educators must focus on designing learning experiences where AI handles information processing, allowing learners to focus on synthesis, evaluation, and ethical judgment. The education systems across the world have struggled with the issues related to quality, scale and equity. But with the advent of adaptive learning platforms and intelligent tutoring systems (ITS), high-quality, personalised feedback can now be scaled to millions of learners. AI can act as a force multiplier. It can help in delivering localised, curriculum-aligned support to teachers in under-resourced settings. This capability positions AI as a critical instrument for social justice and systemic equity. In the post-AI classroom, technology enables educators to rethink traditional approaches, freeing them from routine mechanical tasks and allowing them to focus on fostering human connections that lie at the core of effective learning.

One of the main challenges associated with AI is the dominance of the English language. In a nation like ours, which has 22 official languages and thousands of dialects, AI systems built exclusively on English are inherently exclusionary. Therefore, it's of utmost importance to promote and develop projects that create AI tools which are capable of supporting India's rich linguistic tapestry in the digital age. Another challenge is that of data privacy. To strengthen this ecosystem, it is necessary to incorporate field-specific data protection code into the existing Digital Personal Data Protection Act (DPDP), 2023, particularly in the education sector. Finally, these policy-driven changes must be backed by robust infrastructure. The digital divide, manifested in uneven internet connectivity and device availability, remains the most significant barrier to equitable AI adoption.

The success of AI in education is directly proportional to the workforce's readiness. Current professional development often focuses on basic digital skills or the operation of specific tools. AI competency for teachers must be a multidimensional construct encompassing technical knowledge, pedagogical application, and ethical judgment. Securing this future requires a collaborative model of innovation, where the government, academia, and industry move beyond transactional relationships to form deep knowledge partnerships. The government's role must evolve from a regulator to an enabler, providing the infrastructure and diverse data repositories while establishing firm ethical guardrails. Academia must lead the way in responsible innovation, conducting rigorous, longitudinal studies to validate the efficacy of AI tools before they are deployed at scale, moving us away from hype-driven adoption toward evidence-based practice. Industry, in turn, must be incentivised to develop tools that prioritise pedagogical value over commercial data mining. This ecosystem approach is critical to operationalising the social responsibility pyramid for AI, which prioritises ethical and philanthropic responsibilities alongside functional utility.

As we stand on the threshold of this post-AI era, we must remember that the ultimate purpose of education remains the cultivation of the human spirit. India can build an educational system where AI is not an end in itself but a means to empower every learner to reach their fullest human potential. This is the promise of the NEP 2020, and it is the responsibility of every stakeholder to ensure that in our pursuit of artificial intelligence, we do not lose sight of our collective human wisdom.

Appendix A: Global AI in Education Frameworks

Aspect	Council of Europe (Regulating AI in Education)	OECD Digital Education Outlook (2021)	UNESCO Beijing Consensus (2019)	UNESCO AI & Education Guidance (2021)	UNICEF Policy Guidance on AI for Children (2021)	WEF AI for Children Toolkit (2022)
Background	Emphasizes child rights vulnerabilities, need for human rights–based, risk-proportionate AI regulation with transparency, accountability, and non-discrimination (Council of Europe, 2024)	Focuses on adoption and digital transformations post-COVID, highlighting interoperability, teacher readiness, and privacy concerns (OECD, 2021)	Initiates first global AI-education pact aligned with SDG 4; humanistic, equitable AI deployment and teacher capacitation (UNESCO, 2019)	Provides comprehensive guidance for ethical AI adoption supporting SDG 4, addresses biases, risks, infrastructure, and teacher training (UNESCO, 2021)	Centres child-centric AI aligning with UNCRC; highlights risks, insists on inclusion, fairness, transparency, empowerment (UNICEF, 2021)	Guides ethical AI design focusing on Fair, Inclusive, Responsible, Safe, Transparent (FIRST) framework, promoting child rights and safety (WEF, 2022)

Aim	To develop dedicated, legally binding instruments ensuring that AI deployment in educational settings is human-rights-based, transparent, non-discriminatory, evidence-driven, child-centered, and harmonized across member states; protecting vulnerable groups and upholding the right to education.	To provide research-driven analysis and policy guidance for digital transformation in education, focusing on system-level integration, interoperability, teacher digital competencies, ethical AI use, equity, and privacy – toward more personalized, effective, and inclusive learning.	To establish a global pact for harnessing AI in education, aligning with SDG 4; fostering human-centric, equitable, inclusive, and ethical AI integration through capacity building, policy dialogue, teacher empowerment, and national strategies.	To offer policymakers a practical framework for ethical, human-centric AI integration in education supporting SDG 4; promoting personalization, reducing administrative burdens, and enhancing workforce readiness while proactively managing privacy, bias, and equity risks.	To set out child-centered requirements for AI systems, ensuring empowerment, inclusion, fairness, transparency, data privacy, safety, and proactive stakeholder engagement so AI supports children's holistic development and protects their rights in all aspects of life and learning.	To provide practical tools and frameworks for companies, designers, and stakeholders to develop, label, and deploy responsible, transparent, safe, inclusive, and ethical AI systems that respect children's rights and enhance their positive learning experience.

Outcomes	Anticipates fortified learner protections, equitable AI deployment narrowing digital divides; enhanced educational integrity; pilot programs underway	Digital transformation enhances personalized learning and performance; risks include bias, privacy breaches, limited data interoperability	Facilitated adoption of AI competency frameworks; improved learning outcomes; recognized digital divide and bias risks; policy momentum	Personalization and administrative efficiency achievable; risks include bias amplification and inequitable access; projects substantial SDG 4 progress	Guided global child-centric AI policies; pilot programs show improved educational inclusion; risks entail bias, safety, and privacy concerns	Responsible AI reduces bias, improves safety; adoption supports SDG 4; risks include exclusion and data breaches; emphasis on trust and ethical governance
Key Lessons Learned	-Child-centric regulation imperative -Mandate evidence -based deployment - Inclusive stakeholder ecosystems - Harmonization reduces fragmentation - Risk-based approach balances innovation and protection	-Enhance interoperability and connectivity - Prioritize teacher AI literacy - Promote ethical AI for equity - Build system-wide ecosystem - Regulate generative AI use	- Human-centric AI integration - Focus on equity and inclusion - Develop ethical, regulatory frameworks - Capacity building and partnerships - Continuous monitoring and innovation	- Adopt humanistic, ethical approaches - Research ongoing effects on equity - Build collaborative innovation ecosystems - Address infrastructure gaps - Integrate AI literacy early	- Child participation improves AI relevance - Ethical frameworks key to mitigate bias - Targeted infrastructure for inclusion - Stakeholder collaboration fosters effectiveness - Continuous evaluation critical	- FIRST framework ensures fairness and safety - Transparency builds trust - Diverse ethical governance prevents harm - Ongoing risk evaluation needed - Multistakeholder collaboration enhances inclusivity

Regulatory & Ethical Focus	Advocates dedicated legal instrument emphasizing transparency, non-discrimination, ECHR alignment; standards to address education-specific AI risks	Calls for ethical guidelines emphasizing privacy, bias reduction, teacher roles, data integration	Recommends equitable access, monitoring ethical AI use; integrates AI literacy frameworks globally	Suggests AI literacy and risk assessments; promotes ethical guidelines aligned with human rights and sustainability	Highlights child rights protection, data privacy, safety, empowerment principles for AI in education	Operationalizes ethics through FIRST framework; labelling and inclusive design required for child-safe AI
Stakeholder Involvement & Capacity	Stakeholders including learners, educators, parents involved in AI design and oversight to enhance accountability	Prioritizes teacher training (e.g., Austria's Digi. kompP); calls for system coherence and ecosystem building	Advocates teacher capacitation and public-private partnerships	Emphasizes collaborative ecosystems among educators, tech specialists, policymakers	Promotes child and community participation in policy and design	Provides tools and checklists for parental, design teams and industry stakeholders to ensure ethical AI

Appendix B: Global Trends in AI in Education

Country/ Region	Investments	Accomplishments	Goals	Key Players	Impact Areas
United States	• Private: $47.4B in AI firms (2022); EdTech leaders (Coursera, Duolingo) topped global VC in 2021. • Public: NSF's $20M AI Research Institutes; Dept. of Education grants for AI tutoring. • Philanthropy: Chan Zuckerberg Initiative funds AI platforms.	- K-12 adaptive platforms (i-Ready, DreamBox) widely adopted. - Higher ed chatbots (e.g., Georgia State's Pounce cut summer melt 21%). - Khan Academy's Khanmigo AI tutor piloted. - AI literacy in K-12, high school AI clubs.	- Improve outcomes via AI tutors, translators. - Reduce teacher admin tasks. - Ensure student AI literacy. - Lead in AI talent (500+ students/year). - Promote equitable, ethical AI.	- Govt: Dept. of Education, NSF, IES. - Industry: Microsoft, Google, Coursera, Duolingo. - Startups: Quizlet, Gradescope. - Academia: Stanford, MIT. - Nonprofits: ISTE, Chan Zuckerberg.	- Personalized learning (2–3 months math gains). - Admin efficiency (grading, Q&A automation). - Enhanced student advising. - AI literacy growth. - Ethical AI debates.

China	- Private: $10B+ EdTech VC (2020, 60–65% global share); Zuoyebang, Yuanfudao, Squirrel AI funded. - Public: Post-2021 "Double Reduction" shifted to smart education; 184 AI pilot schools (2023); national AI R&D. - Tech giants (Tencent, Alibaba) invest in AI tools.	- Smart classrooms with AI cameras, facial recognition. - AI curricula since 2018; 500+ universities with AI majors. - Squirrel AI serves millions, claims 70% less learning time. - AI grading for exams.	- Lead AI talent by 2030. - Enhance rural equity via AI. - Reduce teacher workload. - Develop domestic AI systems. - Lead global AI education research.	- Govt: Ministry of Education, Ministry of Industry and IT. - Industry: Squirrel AI, NetDragon, iFlytek, Alibaba. - Academia: Beijing Normal, Tsinghua. - Associations: Education Informatization Industry.	- Personalized learning for large classes. - Data-driven teaching. - Admin efficiency (e.g., attendance). - Increased engagement, AI literacy.

India	- Private: $2.5B EdTech VC (2020), $3B (2022); Byju's raised $2B+, valued at $22B. - Public: NITI Aayog's NSAI funds pilots; DIKSHA AI integration; state investments (e.g., Karnataka labs). - Partnerships: IBM, Intel's AI For All; World Bank AI tutors in Assam.	- CBSE AI curriculum (Grades 8–10) since 2019. - Intel's AI For All trained 1M+ (2021–22). - Mindspark showed 2–4 months learning gains. - Byju's reaches 150M+ students.	- Improve outcomes for 260M students. - Ensure inclusive AI (translation, accessibility). - Universal AI literacy by high school. - Train 1M+ AI professionals. - Ethical, localized AI.	- Govt: NITI Aayog, Ministry of Education, CBSE. - Industry: Byju's, Unacademy, Vedantu. - Global: IBM, Microsoft, Google. - Academia: IITs. - Nonprofits: Central Square, Nasscom.	- Personalized learning bridges gaps. - Access via AI chatbots, translation. - Admin efficiency (grading). - Teacher empowerment. - AI literacy growth.

United Kingdom	- Public: 2019 EdTech Strategy; 2021 AI Strategy funds UKRI, £1M AI safety framework (2023). - Private: Century Tech, Multiverse ($220M, 2022). - Partnerships: Institute of Coding; 2025 "digital revolution" with Google, Microsoft.	- Century Tech in 1,200 schools, 20–30% skills gains. - AI chatbots (e.g., Bolton's Ada) support students. - GCSE AI marking pilots. - 2023 AI school guidelines.	- Reduce teacher workload. - Narrow achievement gaps. - Ensure ethical AI standards. - Train 1,000 AI PhDs by 2025. - Lead EdTech innovation.	- Govt: DfE, Ofqual, AI Council. - Industry: Century Tech, Sparx, Google, Microsoft. - Academia: UCL, Edinburgh. - Nonprofits: EEF, Jisc.	- Teacher efficiency (6 hours/week saved). - Targeted interventions. - Enhanced engagement. - Inclusion (e.g., eye-tracking). - Improved retention.

European Union	- EU: Digital Education Action Plan (2021–2027); Horizon funds L2TOR, Teach4EDUAI. - Private: GoStudent ($340M, 2022), Labster. - National: Finland's Elements of AI; France's €1.5B AI; Germany's KI-Campus.	- Elements of AI educated 750,000+ Europeans. - Estonia's CompuGuard personalizes learning. - France, Germany AI curricula. - Spain's IESA reduces dropouts. - 2022 EU AI ethics guidelines.	- Achieve AI digital sovereignty. - Equitable AI access by 2030. - 80% adult digital skills by 2030. - Lead AI education research. - Ethical, inclusive AI.	- EU: DG EAC, European Schoolnet. - National: Finland, Estonia, France. - Industry: GoStudent, Labster. - Academia: KU Leuven, TU Berlin. - Nonprofits: UNESCO.	- Multilingual education via AI. - Enhanced teacher training. - Data-driven decisions. - Inclusion (e.g., dyslexia tools). - GDPR-compliant AI.

Australia	- Public: $1M AUD for 2023 AI Framework; Digital Literacy Grants; state pilots (NSW, SA's EdChat). - Private: *SmartSparrow* (acquired 2020), *Mathspace*. - Partnerships: Microsoft (*EdChat*), Google.	- 2023 AI Framework for schools. - *EdChat* pilot enhances engagement. - AI in Technologies Curriculum (2022). - ANU's *AI in Schools* course trains thousands.	- Scale safe AI tools. - Reduce teacher workload. - Ensure AI literacy. - Promote equity. - Foster ethical AI, EdTech.	- Govt: Dept. of Education, ACARA, ESA. - Industry: *Mathspace*, Microsoft. - Academia: Univ. of Sydney, ANU. - Nonprofits: AEU, ACER.	- AI-resilient assessments. - Teacher workload reduction. - Improved engagement. - Inclusion for EAL, disabled. - AI literacy, ethics focus.

Glossary of Terms

1. Adaptive Learning: A technology-driven educational technique that uses data-driven instruction to adjust and tailor learning experiences to meet the individual needs.
2. Affective Computing: A field of technology focused on enabling machines to recognise, interpret, and simulates human emotions
3. AI Literacy: A set of competencies that empower individuals to critically understand, use, evaluate and ethically communicate about AI technologies It goes beyond technical skills to include understanding AI's social and ethical implications.
4. Algorithm: A set of rules or processes followed by a computer to solve a problem or perform a task.
5. Artificial Intelligence (AI): Technologies that enable machines to simulate human intelligence by analyzing their environment, learning from data, and making decisions, enabling machines to act autonomously or assist humans.
6. Augmented Reality (AR): An immersive technology that overlays digital information (text, graphics, audio, 3D models) onto the physical world, transforming static learning environments into interactive ones.
7. Automated Essay Scoring (AES): An application of machine learning and artificial intelligence to the field of psychometrics and assessment that evaluates written text

for syntax, coherence, vocabulary, and argument structure by comparing it against human-graded examples.

8. Backward Planning Framework: A curriculum design method that reverses the traditional process; educators start by defining learning objectives, then design assessments, and finally craft instructional activities.
9. Black Box: A metaphor used to describe AI models, especially deep neural networks, where inputs and outputs are known but internal decision-making processes are hidden and difficult for humans to interpret or explain.
10. Blended Learning: An educational approach that combines traditional face-to-face classroom instruction with online digital learning, offering flexible and inclusive learning opportunities.
11. Chatbots: AI-powered applications designed to simulate human conversation to provide information or perform tasks, acting as a virtual assistant.
12. Communicative Language Teaching (CLT): A language teaching approach that emphasises interaction and real-life communication rather than linguistic competence through role-playing, problem-solving, and discussions.
13. Computational Thinking: A problem solving approach to tackle complex issues by breaking down the problem (decomposition), finding patterns (pattern recognition), focusing on key details (abstraction) and creating step-by-step solutions (algorithmic reasoning).
14. Continuous Professional Development (CPD): An ongoing lifelong and planned process of learning, training and education to maintain and improve personal and professional skills, knowledge, and experiences.
15. Culturally Responsive Pedagogy (CRP): A pedagogy that acknowledges and embraces students' cultures, languages and experiences into the classroom instruction.
16. Data Literacy: Ability to read, understand, analyse, and assess data within its context, including recognising

bias and evaluating credibility to make informed decisions.

17. Digital Divide: An unequal access to and effective use of digital technology, creating inequalities, stemming from differences in multi-faceted factors such as affordability, infrastructure, skills, gender, location, etc.
18. Explainable AI (XAI): A process and a set of methods that helps users by explaining the results and output given by AI/ML algorithms, bridging the gap between black box algorithms and human comprehension.
19. FIRST Framework: A set of principles for ethical AI design for children, ensuring tools are Fair, Inclusive, Responsible, Safe, and Transparent
20. Generative Artificial Intelligence (GenAI): A subfield of artificial intelligence capable of creating new content, such as text, images, and code, from prompts by learning patterns from massive datasets
21. Hallucinations (AI): A response generated by GenAI that contains false, misleading or fabricated information while confidently presenting it as factually correct.
22. Haptic Feedback: Technology that creates the sensation of touch, using vibrations, forces, or motions to simulate physical interactions with digital interfaces, making virtual experiences more immersive and intuitive.
23. Immersive Learning: An educational approach that creates learning environments using technologies like Virtual Reality (VR) and Augmented Reality (AR) to create interactive, and simulated experiences, boosting engagement, skill-building, and memory retention in safe, simulated settings.
24. Information and Communication Technology (ICT): An umbrella term for all digital tools and technologies used to handle information and aid communication.
25. Intelligent Tutoring Systems (ITS): An AI-powered computer program that acts like a personal, one-on-one

human tutor, providing customised, real-time instruction, feedback, and support to learners by adapting content and pace to their individual needs, knowledge gaps, and learning styles.

26. Large Language Models (LLMs): Advanced AI systems that are built by training on massive text datasets to understand, generate, and predict human-like language for tasks like writing, summarizing, translating, and coding.
27. Machine Learning (ML): A subset of Artificial Intelligence (AI) that enables systems to learn from data and improve performance without being explicitly programmed for every task, by recognizing patterns and making decisions.
28. Metacognition: The awareness and understanding of one's own thought processes and understanding of the patterns behind them. It also involves control of one's own cognitive processes, like learning, memory, and problem-solving.
29. Multimodal Assessments: Assessments that evaluate learning by combining different communication modes, like visual (images, video), oral (speech, sound), gestural (body language), spatial (layout), and written text, providing comprehensive evaluation.
30. Natural Language Processing (NLP): A branch of AI that enables computers to understand, interpret, and generate human language (text/speech) by analysing patterns, allowing tasks like translation, sentiment analysis, and summarising text.
31. Neural Networks: AI models inspired by biological neural networks, using interconnected nodes (neurons) in layers to process data, learn patterns, and make predictions.
32. Optical Character Recognition (OCR): Technology that converts images of texts (typed, handwritten or printed) into searchable, editable, machine-readable digital data,

enabling digital processing, editing, and analysis instead of manual typing.

33. Pedagogy: Study of teaching methods including theory and practice, encompassing how educators understand learning, design instruction, and interact with students to achieve educational goals.
34. Personalised Learning: An educational approach that customises learning opportunities to individual student needs, strengths, passions, and interests.
35. Predictive Analytics: The use of data, statistical algorithms, and machine learning techniques to forecast future outcomes and identifying patterns for better decision-making
36. Prompt Engineering: The skill of designing and refining inputs (prompts) given to generative AI models to elicit specific and high-quality outputs.
37. Robotic Process Automation (RPA): Technology that uses software robots to mimic human actions and automate repetitive, rule-based digital tasks like data entry and system integration.
38. Scaffolding: A teaching method where educators provide temporary support to help students learn new concepts or skills, gradually removing the same as students gain confidence and mastery, enabling independent learning.
39. Spaced Repetition: A learning technique that improves long-term memory by reviewing information at strategically increasing intervals over time, usually performed with flashcards.
40. Technological Pedagogical Content Knowledge (TPACK): A framework describing the knowledge teachers need to effectively integrate technology into teaching, blending their understanding of Content (what to teach), Pedagogy (how to teach), and Technology, to create effective, technology-enhanced learning experiences for students.

41. Techno-solutionism: The belief that complex societal problems can be solved primarily or solely through technological innovation, often oversimplifying issues into technical puzzles and neglecting deep-rooted social, political, and ethical factors.
42. Universal Design for Learning (UDL): An educational framework that guides the development of flexible learning environments that can accommodate individual learning differences by offering multiple ways to access information, engage with material, and show what they know, based on neuroscience of how people learn.
43. Virtual Reality (VR): Use of computer modeling and simulation that allows users to interact with an artificial three-dimensional (3-D) visual or other sensory environment in a very realistic way.
44. Zone of Proximal Development (ZPD): A concept defining the difference between what a learner can do alone and what they can achieve with guidance from a more skilled person.

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Member Secretary

गुरूर्गुरूतमो धाम
NCTE

राष्ट्रीय अध्यापक शिक्षा परिषद्
(भारत सरकार का एक सांविधिक निकाय)
National Council for Teacher Education
(A Statutory Body of the Government of India)

File No: NCTE-Acad020/1/2025-Academic Section-HQ

5th August,2025

Office Order

In view of the growing role of Artificial Intelligence (AI) in transforming education system globally, and in alignment with the vision of NEP 2020 to integrate technology in education meaningfully, it has been decided to constitute a committee to develop a comprehensive, forward-looking, and actionable scholarly document **(Monograph on AI in Education and its Application in Teacher Education)** to guide faculty, academic institutions, and policymakers in implementing AI in the broader field of education, with a special focus on its relevance and application in teacher education.

S.N.	Name & Address	Designation
1.	Prof. Ashutosh Bhardwaj, Vice Chancellor, Mody University, Rajasthan	In-Chair
2.	Prof. Ruchir Gupta, Dept. of Computer Science & Engineering, IIT, BHU	Co-Chair
3.	Prof. Priya Ranjan, Buddha World University, Vaishali, Bihar	Member
4.	Dr. Subhash Chandel, CIE, University of Delhi	Member
5.	Shri D. K. Chaturvedi, Academic Advisor, NCTE	Convener
6.	Dr. Waheed Ahmed Ahanger, Academic Consultant, NCTE	Co-Convener
7.	Mr. Mukund Jha, Data Analyst, NCTE	CP Nominee

Terms of Reference (ToR) of the Committee:

1. To examine the current landscape and emerging trends in the application of Artificial Intelligence (AI) in education at both national and global levels, with a special focus on its role in teacher preparation, professional development, and classroom practices.
2. To identify key areas for integrating AI in teacher education, including curriculum design, personalized learning, assessment systems, professional development, and educational administration, while also assessing associated ethical, pedagogical, and infrastructural considerations.
3. To develop a strategic, inclusive, and actionable framework to build institutional and faculty capacity for the effective adoption of AI tools and platforms in teacher education.
4. To recommend relevant models, case studies, and best practices from India and abroad that showcase effective AI implementation in teaching, learning, and teacher training, supported by engagement with key stakeholders such as educational technology experts, teacher education institutions, regulatory bodies, and AI practitioners.
5. To propose policy-level recommendations to enhance institutional readiness, strengthen digital infrastructure, and foster innovation ecosystems in education and teacher training.
6. To ensure timely completion of the task, with the final document to be submitted to the competent authority in NCTE within two months from the date of the committee's constitution.
7. The Committee may co-opt additional members or experts as required, subject to prior approval from NCTE, to strengthen its work and recommendations.
8. NCTE shall provide all necessary logistical support to the Committee. Members shall be entitled to TA/DA as per NCTE norms.

This issues with the approval of the competent authority.

(Abhilasha Jha Misra)
05/08/2025

Copy to:

1. SO to CP / MS, NCTE
2. DS/ US/SO, Academic/Admn. /Accounts, NCTE
3. All Concerned

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(भारत सरकार का एक सांविधिक संस्थान)
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NCTE
National Council for Teacher Education
(A Statutory Body of the Government of India)
By e-mail / Hand / Speed Post / Fax

08th May 2026

OFFICE ORDER

In continuation of the Office Order vide File No. NCTE-Acad020/1/2025-Academic Section-HQ dated 5th August 2025 regarding the constitution of the Committee for the preparation of the scholarly document, it is hereby notified that the title of the document has been revised from the monograph titled *"AI in Education and its Application in Teacher Education"* to the book titled *"Artificial Intelligence (AI) in Teacher Education."* Accordingly, the following members are hereby included in the Committee:

S. No.	Name & Address	Designation
1.	Dr. Amit Kumar Jaiswal, Department of Computer Science & Engineering, IIT BHU	Co-opted Member
2.	Yashi Goyal, Research Scholar, CIE, Delhi University	Research Assistant

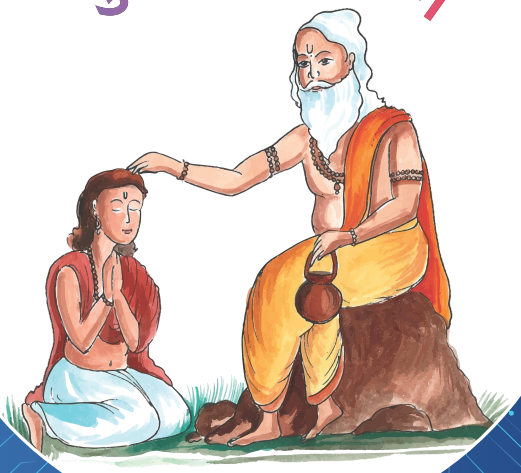
All other terms and conditions of the above-mentioned Office Order shall remain unchanged. This has been issued with the approval of the Competent Authority.

- Sd -
(Deputy Secretary)

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3. All concerned Members.

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