



GENERATIVE AI AND THE FUTURE OF TEACHING AND LEARNING: EDUCATIONAL INNOVATION, RISKS, AND RESEARCH DIRECTIONS

Dr. Shital Chandrakant Nathgosavi^{1*}, Dr.Durga Shyamsingh Bais², Dr.Durga Shyamsingh Bais³, Dr. Priyanka Sudamrao Deshmukh⁴

^{1*} Associate Professor, Ayurveda Sanskrit, Samhita & Siddhanta, SSVP Ayurveda college & Research Institute, Email id: dr.shtlgosavi@gmail.com, ORCID iD: 0009-0007-9422-7087

² Assistant professor, Samhita Department, SSVP Ayurved College, Hatta, Tq. Basmat, Email id: drdurgabais123@gmail.com

³ BAMS MD (Ayu), Assistant professor, Samhita Department, SSVP Ayurved College, Hatta, Tq. Basmat, Email id: drdurgabais123@gmail.com

⁴ BAMS MD (Ayu.), Assistant Professor, Samhita Department, SSVP Ayurved College and Research Institute Hatta, Hingoli, Email id: priyankadeshmukh.c@gmail.com

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ABSTRACT

Generative AI (GenAI) has become a prevalent education technology that can create explanations, feedback, assessments, and academic content. This is a narrative review that consolidates the latest insights on the implications for teaching, student learning, assessment, personalization, the role of the teacher and the learner, academic integrity, ethical risks, institutional adoption and future research. The evidence indicates that GenAI has the potential to improve the efficiency of instruction, provide formative feedback, support learners, and enable human-AI interaction. It has, however, a restricted educational potential due to hallucination, bias, opacity, privacy issues, unequal access, overreliance, and difficulties with subjective authorship and assessment validity. To achieve effective integration, the pedagogical design needs to be intentional, disciplinary judgment is needed, AI literacy is essential, transparent governance, and continuous human oversight. Future research must go beyond short-term perceptions to include long-term and comparative studies focused on learning outcomes, cognitive effects, equity, institutional conditions, and sustainable models for responsible integration of GenAI.

1. Introduction

The advent of Generative AI is one of the most impactful technological advances on modern schooling. Unlike the previous generation of educational technologies which stored and transmitted information, or organized it, GenAI can generate new information, including text, images, explanations, examples, code, questions and feedback, based on natural-language prompts. They have been diffused fast and have changed the actual situation of students' learning and teachers' teaching design. They have diffused quickly and changed the actual situation of students' learning and teachers' designing of instruction. A learner may now ask for an explanation at any desired degree of difficulty, make examples as needed, repeat a conversation, discuss various possible solutions, or get comments on a draft. The same systems can be used to create learning activities, variants of learning materials, regular communication, and explorations of new forms of formative interaction. This versatility accounts for the rapid move of GenAI from an emerging technology to a key topic in the ongoing conversation regarding the future of education and learning.

Large language models are particularly important as they shift the user interface between computational systems and educational users. In the past, those applications of AI in the education sector were limited to specific applications, specific environments, and the presence of an expert. Modern language models, on the other hand, are user-centric, can be used through dialogue interfaces and can be used in multiple fields without the need for much technical expertise. The educational value of these is therefore two-fold: algorithmic sophistication and accessibility, linguistic flexibility and ability to engage in open-ended academic activities. Kasneci et al. (2023) view this development as a result of significant educational opportunity and significant challenges in reliability, fairness, access, and responsible use. Technology therefore opens new avenues of learning engagement and challenges existing frameworks of knowledge making and study.

Adoption speed has also led to an inability to catch up with technological change and education understanding. The use of ChatGPT and other generative tools started in many institutions before curricula, assessment rules, staff development programs, and institutional governance were repurposed to address generative tools. Early educational responses then ranged from prohibition to experimentation, sometimes lacking in adequate proof base. As mentioned by Lo (2023), the literature that has been published is related to teaching support, student learning, assessment, academic integrity and institutional issues, while also being in a nascent stage of systematic educational evaluation. The lack of uniformity poses the challenge of separating out short-term novelty from long-term pedagogical merit.

Thus, the educational discussion goes beyond a simple dichotomy of benefit or harm of GenAI. The impact on the task, learner, teacher, disciplinary context, prompt and output quality, and rules governing its use in the institution all influence its impact. A conceptual explanation support system that works in one setting can fail to foster productive struggle in another setting, and a tool that aids the educator in creating questions for his or her students can be undermined by student use in creating unvalidated responses. The dual nature of ChatGPT is presented by Tlili et al. (2023) as an example of how ChatGPT can be used as an educational assistant and as a source of new ethical, pedagogical, and governance issues. This is a tension and synthesis is more valuable because it is not the case of making isolated judgements on platforms.

Hence, this narrative review explores the transformative impact of GenAI on teaching and learning, assessment, academic life, and education institutions. Explores the history of the emergence of GenAI in the field of education, reviews its applications in the classroom and to the learner, examines how it can be used to personalize learning, looks at the shifting roles of teachers and learners, and discusses academic integrity, ethical risks, and implementation challenges. These strands are then brought together to determine the priorities for research on responsible educational adoption for the review. The analysis does not assume that GenAI is a technology that is in place, but rather a socio-technical capability that is changing, with the educational implications that occur when the tools, users, pedagogies, and institutional arrangements interact. These dimensions are interlinked and connect the GenAI capabilities to the applications for education, risks involved, governance needs, and expected educational outcomes as shown in Figure 1.

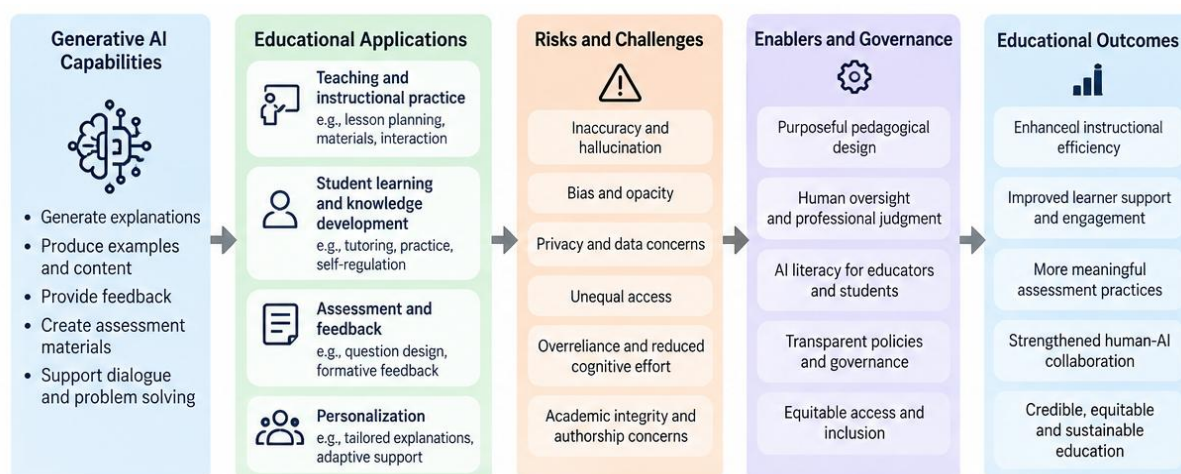


Figure 1. Conceptual Framework of Generative AI in Teaching and Learning

2. Evolution of Generative AI in Education

In education, GenAI can be seen as a continuation of a longer journey from a reliance on one-way digital information to dynamic and more multilingual computational forms. Content and communication were digitized by early educational technologies, resources and activities were organized by learning management systems, learning responses were modelled by intelligent tutoring systems (in limited domains) and interaction in natural language was introduced by conversational agents in selected educational functions. GenAI takes this forward by allowing systems to produce contextually relevant content instead of just delivering preprogrammed responses. The change is thus functional rather than technical; it is possible for educational software to be involved in drafting, explanation, ideation, translation, questions generation, etc., which were formerly the realm of human language production.

Large language models have fueled this shift, since the same general-purpose conversational systems can be applied to different educational settings and not course or discipline specific. This flexibility allowed for opportunities to provide spontaneous tutoring, writing support, coding assistance, lesson development and feedback. Mai et al. (2024) summarize the field of ChatGPT in teaching and learning as one that is both strong and weak: on the one hand, it is accessible and responsive, and on the other hand, it is not always reliable, it creates dependence, it can cause the misuse of assessment, and pedagogical frameworks are not sufficiently developed. The pattern can be differentiated from earlier attempts to use educational technology, since it can be used to facilitate a legitimate learning process or to facilitate a learning process that avoids the use of the same tool.

GenAI has also shifted the paradigm of learning intelligence. In traditional learning software, design is incorporated mostly into the system prior to its use. Generative systems involve enough functionality being negotiated in interaction, through prompts, "next" questions, examples, constraints and iterative refinement, that a large part of it is not specified in advance. Users thus are active co-configurators of the educational behaviour of the system. This puts a new emphasis on having a high-quality prompt, domain knowledge, and evaluative judgment. It also implies that two learners working with the same model can have quite different learning results, depending upon the difference in how they interact: purpose, specificity, verification, and persistence.

Rahman and Watanobe (2023) describe ChatGPT as both providing opportunities for education and research and posing threats that need explicit strategies. The framing they use reflects a larger historical evolution from the integration of AI as a part of the teaching process to the presence of AI as a conversational partner in learning. The system no longer just automates, but can provide candidate explanations, arguments, examples and feedback. Thus, the focus of the central educational question has shifted from "Can AI be used to help with instruction?" to "How should human judgment design, validate, and manage AI-generated contributions to instruction?"

It also alters the definition of digital competence as it evolves. The traditional definition of digital literacy focused on information-seeking, information-literacy, software and online communication.

GenAI introduces new requirements to craft appropriate requests, review generated texts, find claims that are not supported, identify uncertainty, compare outputs to the evidence of the discipline, and properly acknowledge the use of AI. The educational shift is not a shift towards more powerful tools. It is towards learning environments that involve critical engagement with machine-generated content as a core component of the learning process itself.

3. Generative AI in Teaching and Instructional Practice

3.1 Instructional Design and Content Development

Generative AI can aid in creating lesson plans, discussion questions, examples, case scenarios, quiz questions, and explanations on varying levels of complexity. These outputs can save some effort in initial preparation and provide flexibility for educators to customize materials to suit the needs of various learners. The generated text can be incorrect, not aligned to learning outcomes or pedagogically inappropriate, however. ElSayary (2024) notes that teachers need to critically engage, adapt, and situate ChatGPT's output before using it in the classroom.

3.2 Faculty Productivity and Pedagogical Integration

GenAI can help faculty be more productive by helping with mundane instructional preparation, communication and content writing. This can enable teachers to spend more time with students, giving feedback and making more complex choices in teaching. But the benefits of efficiency rely on teachers being able to validate and correct AI-generated material. Lee et al. (2024) demonstrate that teachers are aware of the potential of GenAI and the issues regarding reliability, assessment, and staff preparedness. To achieve effective integration, AI literacy, institutional guidance and ongoing professional judgment are essential.

3.3 Classroom Interaction and Pedagogical Innovation

GenAI can also enable students to engage in active learning – asking students to question answers, make comparisons, spot assumptions, and test evidence. These activities use AI as an analysis tool and not just an answer generator. Conversational AI's educational capabilities have been called out by Bettayeb et al. (2024) and the significant shortcomings are outlined. Pedagogical innovation, therefore, relies on the creation of tasks that maintain reasoning, reflection and cognitive activity, and teachers must decide where AI can add value to learning without taking the place of cognitive activity. The instructional value of GenAI is made up of its integration in content creation, faculty productivity, and classroom engagement with continued teacher supervision (summarized in Figure 2).

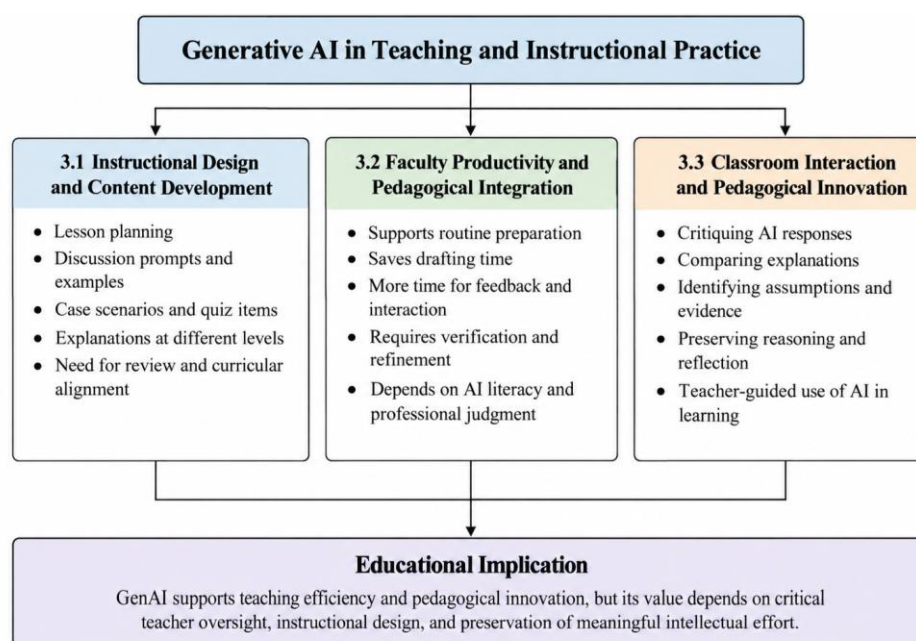


Figure 2. Generative AI in Teaching and Instructional Practice

4. Generative AI for Student Learning and Knowledge Development

4.1 On-Demand Learning Support and Virtual Tutoring

Generative AI can offer instant academic assistance by answering subsequent queries, breaking down complex ideas, creating examples, and providing explanations beyond class time. Deng et al. (2025) demonstrate that ChatGPT can facilitate learning, but the advantages vary depending on how students use it. Ding et al. (2023) also illustrate how ChatGPT can serve as a virtual tutor, notably in the context of clarifying concepts and engaging with students in a dialogue.

4.2 Self-Regulated Learning and Student Agency

GenAI can help students plan their studies, generate practice questions, revise, and provide feedback, which can facilitate their self-regulated learning. The advantages of this however, are contingent upon students' ability to keep control of learning rather than cede it over to the system of planning and reasoning. Students are aware of the value and constraints of generative AI, suggesting that their awareness, judgment, and responsible use of these tools are essential for effective use (Chan & Hu, 2023).

4.3 Critical Thinking and Knowledge Development

Task design plays a crucial role in the critical thinking impact of GenAI. Instructing students to accept the answers they produce as they look for their own independently may limit engagement with critical thinking, whereas activities that ask students to check claims, find inaccuracies, compare explanations, and assess evidence can promote critical engagement. The educationally valuable role of GenAI is thus most in the context of inquiry and reflection but not cognitive labor.

5. Generative AI in Assessment and Feedback

5.1 Assessment Redesign in the Generative AI Era

The conventional assessments, such as essays, summaries, short answers, and other forms of writing, can now be generated with significant AI support, introducing a new challenge for generative AI. In their proposal, Fount et al. (2024) suggest that this should shift to more flexible and re-designed assessment practices that focus on process, authentic application, staged submission, oral explanation, and reflective justification. This can help to differentiate the learning outcomes of the learner from mechanical content creation.

5.2 AI-Generated Feedback and Evaluation

GenAI can also enhance formative assessment by providing instant feedback, exercises to practice, and initial comments on student work. Automated feedback, however, can be nondiscriminatory and potentially misinformed or lack the sensitivity to a specific discipline. Newton and Xiromeriti (2024) demonstrate that ChatGPT can be useful for some traditional assessment formats, highlighting the importance of human oversight and assessment approaches that go beyond the typical making quick answers.

5.3 Question Design, Rubrics, and Assessment Governance

In the field of assessment, GenAI can help create questions, item variants, scenarios and draft rubrics, which can potentially save educator's time. However, materials created need to be reviewed for accuracy, bias, difficulty, and curricular content. Xia et al. (2024) argue that GenAI is changing the nature of assessment in a more general sense, so transparency, policies for using GenAI, and the distinction between formative and summative use are becoming more significant for the validity of assessment.

6. Personalized and Adaptive Learning with Generative AI

Personalization has been a key goal of education technology for a long time, and GenAI reinvents its practice. Conversational systems can adapt their explanations, examples, tone, language and detail in real-time based on the learner's requests, rather than based on pre-defined adaptive pathways. A student may have a question regarding the explanation in a different words, ask to see an example,

ask to translate a concept or ask if the explanation could be switched to a walk-through of a procedure. This flexibility gives the impression of tutoring that is individualized, even if the model does not have a stable understanding about the learner.

In exploring the use and perception of Generative AI by college students, Baek et al. (2024) offer evidence that college students use Generative AI in a variety of ways in their academic endeavors and that there are varied perceptions of Generative AI. This variation is crucial because personalization is in part driven by the learner: What to ask for, how much to rely on it, and whether to use it as a brainstorming tool, explanation, draft, or for verification. What is different about GenAI compared to many adaptive systems is that the personalization may come from a conversational negotiation, rather than a formally designed "learner model."

The flexibility of this user-driven approach can help meet the varying learning needs. Multilingual learners can ask for alternative phrasing or a translation; students who possess limited prior knowledge can ask for stepwise explanations; advanced learners can ask for counterarguments or more challenging examples. However, the apparent adaptability can be confused with inconsistency. Often a response to a student's request can include errors, omissions, and assumptions in the course of being tailored to meet the student's needs. Personalization must thus be paired with means for checking and with consciousness of fluent adaptation as evidence of pedagogical diagnosis.

The potential for personalization is complicated by differences in access and usage. The study by Stöhr et al. (2024) examines the gender differences, academic standing, and disciplinary backgrounds regarding perceptions and usage of AI chatbots, revealing that the adoption of these tools is not even. Personalized benefits won't necessarily be evenly distributed if students have different levels of awareness, confidence, disciplinary norms, language, access to paid tools, or understanding of effective prompting. Organizations implementing GenAI should thus not just focus on availability, but also on the capabilities needed to take GenAI to good use.

Another factor determining adaptive value is acceptance. Building on the extended technology-acceptance approach, Strzelecki (2024) examines the relationship between student engagement and students' perceptions of usefulness and ease of use with ChatGPT in higher education. This is important because if the students don't have trust in the system and don't understand what it is for, or if they use it indiscriminately, students will not learn from it, even if the system is technically capable of doing so. To personalize effectively, a healthy level of skepticism is required as well as trust, so that one can use the tool constructively but also be certain of important outputs.

Personalization is therefore the strongest education model, not fully automated but guided, is therefore the best education model. The teacher sets the learning objectives and limits, the student asks for support in the form of GenAI, and both are alert to signs of learning. This is a pedagogically supplemented conversational adaptability arrangement. It can widen the scope of support but, as with any other area of learning, it is the human and disciplinary interpretation that determines progression, difficulty, misconceptions and learning quality.

7. Changing Roles of Teachers and Learners

The expanding use of GenAI is reshaping the role of educators as tasks that were traditionally thought to be the province of teachers and students are becoming part of the computational process. Initial writing of explanations, questions, or examples can be delegated to teachers and students can get writing, planning, and problem-solving help when needed. It's not that either role is gone, but it's redistributed. The question that emerges in relation to the educational issue is what kinds of functions are appropriate to be automated, what functions should be enhanced, and what functions should remain essentially human due to their care, contextual judgment, accountability, and/or interpretation of learner development.

In a direct exploration of the possibility of generative AI replacing teachers, Chan and Tsi (2024) ask students and teachers to compare their perceptions. Role transformation is a more realistic alternative to substitution. Teachers continue to have the responsibility to create purposes, develop standards, make judgments about learners' needs, establish social learning environments, and make consequential judgments. While GenAI can streamline some repetitive production tasks, it can simultaneously make orchestration, mentoring, and assessment design, as well as critical mediation,

more crucial.

It also demands a new professional competence for the teacher to work with AI. As AI evolves rapidly, educators must grasp how GenAI can assist their students, its limitations, the influence of prompts, and the acceptable ways students can use it. They should also learn how to verify the content produced by GenAI. In a scoping review of AI literacy in teacher education, Sperling et al. (2024) reveal that AI literacy training for teachers is not just about understanding how to use the technology. It demands critical, ethical and pedagogical comprehension for informed rather than automatic decisions on integration, and not merely to use tools already available.

The roles of the learners are changing as well. The ability to generate explanations and drafts on the fly requires the need for increased students' problem definition skills, output quality assessment skills, missing evidence identification, and final academic decision making. Agency is indeed more important, not less. A learner who cannot tell the difference between help and removing parts of the AI's output may become dependent on the AI, but a learner who can question and modify the AI's work can use the AI as a thinking partner without taking away the responsibility for the task.

Tzirides et al. (2024) highlights the importance of integrating both human and artificial intelligence to enhance the literacy of AI in higher education. This human-AI framing is better than an all-or-nothing approach. It understands that there are complementary strengths, with AI generating alternatives quickly and humans adding context, goals, values, accountability and evaluative judgment. The objective of AI literacy is not just technical skills, but also about making informed decisions and working cooperatively.

Human supervision is still required, as educational decisions can have repercussions that are not easily handed down to probabilistic text generation. Feedback should be given only if the teacher judges the learner competent, appropriate, curriculum appropriate, and activity appropriate for intended learning. Students should evaluate information generated by AI to determine its credibility and check if the use of AI is appropriate for the course. This new division of labor replaces knowledge with judgment as the paramount human educational power.

8. Academic Integrity, Authorship, and Assessment Challenges

The issue of academic integrity is now a major concern given that GenAI can generate convincing-looking academic prose, without any discernible signs of its generation. While traditional plagiarism tools are based primarily on the reuse of language or ideas that are not attributed properly, GenAI can produce new languages that could be entirely without similarity to a previously used source. This makes it difficult to detect and to conceptualise the nature of misconduct. The question is growing increasingly whether a student has presented work created using AI as proof of his or her own work when the work was meant to be done independently.

Cotton et al. (2024) examines academic integrity in a context where students can be helped by ChatGPT and emphasize that institutions must think about how to assess and enforce policies to address academic integrity more than just through traditional notions of cheating. Clear rules are especially significant as there can be a continuum of legitimate and illegitimate uses. Brainstorming, language polishing, translation, outline generation and substantive drafting, are different intellectual contributions. Therefore, courses should have clear statements of what is allowed, of disclosure, and of responsibility for accuracy.

Authorship is related to but different from misconduct. Authorship conveys responsibility for claims, evidence, reasoning, and interpretation. As a scholarly agent, a generative model can make no guarantee of accuracy, cannot claim intellectual property in the text, nor can it defend an argument that it produces. A generative model cannot claim responsibility for errors or defend an argument submitted to it, so the student or researcher will still be responsible for submitted work even if the model contributes language or ideas. This principle helps to ensure that the material is clearly identified as being produced with the aid of AI and that its use does not give the impression that the AI system is the author.

Student behaviour also demonstrates why policies can't be based solely on 'assumptions of misuse. Students' experiences and expectations of the use of a chatbot to support assessment, as explored by Gruenhagen et al. (2024), indicates that GenAI is also now deeply entrenched in practical academic

decision making. Students consider their convenience, perceived legitimacy, difficulty in use, and institutional guidance in determining use of these tools. If policy is not specific and isn't connected to practice, then it can lead to uncertainty, not integrity.

Authentic assessment has been suggested as a solution because tasks that have real world applications, local data, oral defense, iterative development, and/or reflective justification are more difficult to "outsource". In this study, Kofinas et al. (2025) look at how GenAI impacts academic integrity in authentic assessments, highlighting the importance of testing assumptions around which task designs are likely to be effective in AI-rich environments. Authenticity should not be thought of as an exemption from aid by the use of AI; it should rather be considered as enhancing the evidence of learning when accompanied by process visibility and by opportunities for explanation.

Detection tools are unlikely to provide a complete solution. AI-text detectors can also sometimes return false positive and false negative results, particularly as models and writing styles change. A trust-destroying strategy of surveillance is also available if students are accused on shaky evidence. More sustainable approaches involve developing clear policies, redesigning the assessment, disclosure practices, oral or process-based verification where possible, and explicit teaching of responsible AI use. The goal is to preserve the integrity of learning and evaluation, not technology for technology's sake.

9. Ethical, Social, and Educational Risks

Academic integrity is not the only educational risk of GenAI. Language models may produce false information, amplify social biases, conceal the origin of claims, and impart a sense of authority through a high level of fluency. Such attributes are especially significant in the educational context, where students are not necessarily equipped with the knowledge of a domain to see certain mistakes. The risk here is both epistemic and technical, in that students can be given explanations that are confident, coherent, but with unsupported or incorrect elements.

Albadarin et al. (2024) draw together the empirical evidence of ChatGPT in education and demonstrate the full scope of problems arising from the use of technology in the real world of education. One focus is that early studies often bear multiple benefits, accompanied by methodological limitations and variability in setting. It is important that ethical assessment not equate positive user perceptions with educational effectiveness and that the benefits of short-term convenience not be used to support unconstrained uptake. Evidence needs to be evaluated within the context of learning goals, user attributes and the context of technology use.

Emphasis is needed on bias and fairness. GenAI is modeled on large volumes of human-made data, and can recite stereotypes, entrenched cultural beliefs, and inequitable representation. Bias in examples or suggestions can have an impact on students' understanding of social groups, disciplinary history, or career options in educational settings. Distributing access is also fair. Some students, with a subscription to a service, with a greater degree of skill in using digital tools, with a higher connectivity level or with previous experience of using AI could obtain more successful support than others who do not have those resources.

The importance of context supports what has been seen globally. Ravselj et al. (2025) found significant cross-national and socio-demographic differences in the HE students' perceptions and use of ChatGPT. There are no universal experiences for students when it comes to GenAI. To design an educational policy that avoids perpetuating inequalities in digital infrastructure, language resources, institutional guidance, disciplinary culture, and previous technological exposure, disparities must be considered. A tool which feels empowered in one context can reinforce the sense of disadvantage in another.

Another risk is privacy and data protection since pupils and teachers may enter personal information, institutional or published information into external systems without being aware of how this data is processed. Educational institutions must establish rules regarding sensitive data, particularly in classes that involve clinical, legal, commercial or personal identifiable information. The principles of transparency are also applicable: users should be aware of the roles of AI in providing feedback, content creation, or decision support, and they should know when and how AI's authority is restricted. The ethical aspects of assessment redesign are also relevant, as institutions need to be balanced to

both be fair and honest. Lye and Lim (2024) explore the principles to consider for assessment redesign in tertiary education in the context of GenAI, highlighting the importance of taking a thoughtful approach. Restrictive policies can penalize valid learning support, and undesirable policies can have an adverse impact on students using assistive technology; permissive policies may decrease evidence of individual learning. Ethical governance, therefore, should have proportionality, clarity, accessibility, and attention to educational purpose.

Overdependence is an extended-term educational danger. Routinely delegating explanation, planning, synthesis, and drafting might not give learners the opportunities they need to acquire the skills needed to make their own expert judgments. What should NOT be done is to give up on providing any support whatsoever, but to ensure that there are deliberate moments for unaided practice, students are expected to explain the reasoning behind their choices and tasks should provide students with opportunities to check and modify AI output. Responsible use should enhance, not diminish, intellectual agency.

10. Institutional Adoption and Implementation Challenges

AI tools are not enough to drive institutional adoption of GenAI. For universities and schools, technology choices need to be made in conjunction with curriculum, assessment, teacher/curriculum staff development, privacy, accessibility, infrastructure, and academic integrity. However, given the multifaceted impact of GenAI, there may be inconsistencies in policies if they're fragmented. Learning support may be encouraged in a system while not allowed during assessment or may be allowed to staff while not allowed to students or may be built into platforms without knowledge. Coherent governance, therefore, must be able to differentiate contexts of use and give reasons for varying rules. One of the earliest institutional responses has been the development of policies. In a report on guidance and assessments from top universities on generative AI, Moorhouse et al. (2023) reveals that institutions have had to make rapid rulesets in response to technological change. The variety of responses highlights uncertainty on what acceptable usage is and the challenge of policy design for technologies that are rapidly changing. Good governance needs to be principled enough to be relevant and yet needs to be specific enough to inform tasks to which students and staff can apply it.

It is also crucial that faculty are well prepared. Teachers must be provided with spaces to explore GenAI, explore implications for their discipline, re-imagine assessments, and establish shared expectations. PD should not just be about prompt techniques. It should address the issues of verification, bias, privacy, copyright, assessment validity, disclosure, accessibility, and pedagogical design. This more comprehensive preparation is absent, and adoption might be based on individual enthusiasm or anxiety instead of evidence-informed practice.

The challenge of curriculum redesign is another one, as the competency in AI literacy is increasingly connected to disciplinary competency. The students from various fields should have some knowledge of the generic AI risks and the impact of GenAI on their professional practice. Kohnke et al. (2026) explore aspects of preparation for responsible GenAI use in teacher education, highlighting implications for the curriculum in the areas of ethics, privacy, and AI literacy. This is a broader institutional need: Responsible AI competence needs to be integrated into programs and not just a technical skill.

Implementation is also influenced by cost and scalability. There could be a difference in the features of free access systems and institutionally licensed systems, and institutionally licensed systems may take significant time and effort to procure, review, integrate, and support. Institutions need to consider the potential of GenAI investments in enhancing learning to be worth sustaining and the potential for equitable benefits. In the context of technology purchases, therefore, it is important to tie them to educational goals and not to the race to be "innovative".

Institutions will incorporate governance, infrastructure, pedagogy and evaluation in a mature form. It should define acceptable use, safeguard sensitive data, enable staff development, offer guidance to students that is easy to access and have processes to review impact. Importantly, the institutional policy should be amendable. Static rules cannot explain the capabilities of GenAI systems, let alone the evidence of their learning outcomes. Governance should thus be a continuous learning cycle, with monitoring, consultation and research.

11. Discussion and Future Research Directions

The research that has been looked at here indicates that GenAI won't be a standalone classroom tool or just a short-term addition to traditional educational technology. It is developing into an infrastructural competency to be integrated into nearly all aspects of academic work, including planning, explanation, production of content, tutoring, feedback, assessment, revision, and administrative communication. This wide breadth makes it easy to learn but also challenging. Just as a system that is useful for personalized explanation is also useful for unacknowledged task completion, so is a system that is helpful for teachers in creating materials also helpful for students to produce misinformation; and a system that is convenient for students to use, can also lead to new forms of dependence.

One central synthesis is that educational value is not about having a tool but about its configuration. GenAI has the greatest potential to make a significant contribution in tasks that involve learners evaluating, comparing, justifying, and applying information. It is not as defensible educationally when it replaces the mental exercise the activity was intended to provide. This distinction takes focus off of the tool and onto the design of the instruction. Institutions should not only ask students if they are permitted to use GenAI, but which use will ensure the validity of the process of intended learning.

The research base, however, is not evenly distributed. The higher-education literature on ChatGPT has significant research gaps, as noted by Baig and Yadegaridehkordi (2024), among others, given the fast-paced publishing of research, the diversity of research methods, and the strong focus on perceptions and short-term solutions. Future research should include more causal designs, clear reporting of versions and prompting conditions of the model, replication across disciplines, and consideration of the variation of outcomes as students become more experienced users. Studies should also differentiate between productivity, satisfaction, short-term task performance, conceptual understanding and retention of information over time, rather than using all these as synonymous measures of educational outcomes.

Longitudinal research is important because the most significant effects could only result after repeated use. Pupils who use GenAI for several months or years could acquire new strategic skills but also might not get sufficient practice in the core skills. Research should explore the impact of frequent AI support on writing development, problem representation, metacognition, source evaluation, memory, and perseverance during challenging writing tasks. Just as a continuous inquiry can impact on lesson preparation, feedback practices, workload distribution, and educators' sense of professional expertise, the same can be said for students.

Comparative research is also required at various educational levels, in various disciplines, in a variety of languages and within various institutions. Existing evidence tends to be focused in education, and in environments where access to top-tier AI systems is not too difficult. The impact of GenAI could vary significantly in school, vocational education, low-resource settings, multilingual classrooms and subjects that are more practical or clinical. Equity should therefore be studied as a research question, instead of being just a moral issue.

There is also a need to further study the pedagogical process of human-AI interaction in the field. Prompting should not only be learned as a technique but as a form of inquiry which can inform reasoning, question formulation and metacognitive monitoring. Research needs to consider what are interactions enable students to question the output of AI, when is it appropriate for feedback to help with revision rather than polishing up texts, and how can teacher mediation influence the quality of the learner-AI interaction. This type of research can contribute to the transition from the general to the specific in the field of personalization towards the evidence-based approach to guided educational interaction.

Farrokhnia et al. (2024) employ a SWOT analysis to illustrate the mixed educational implications of ChatGPT, accentuating the relationships between its strengths and weaknesses, opportunities and threats. This balanced framing is useful for future policies and research. Responsible integration should not seek to optimise the use of AI, but rather focus on determining where GenAI can add learning value that is hard to achieve without it, and where it can detract from learning, fairness or accountability, providing protection in those areas.

Future studies should therefore focus on a few key areas: a rigorous measurement of the learning

outcomes; long-term cognitive and behavioral impacts; discipline specific pedagogies; equity and accessibility; trustworthy feedback and verification; privacy respecting institutional architectures; strong assessment models; and professional development of teachers. Governance's own study as a subject is also an area that needs research to be undertaken, on the one hand to find a model of governance that provides clarity without over-restriction, and on the other, to monitor and adjust the rules of the institutions as technology evolves. The ultimate objective is to develop an evidence base that can support stable educational principles in a rapidly changing technical environment.

12. Conclusion

Generative AI is transforming education and empowering teachers to provide education beyond the creation and explanation phase, to feedback, assessment, and learner interaction. However, the pedagogical integration is more important than the technological skills in terms of educational value. While these advantages—from instructional efficiency to personalized support, formative feedback and innovative learning activities—coexist with concerns about inaccuracy, bias, academic integrity, privacy, transparency, unequal access and overreliance—genAI holds promise for enhancing educational experiences. The best way forward is thus neither total bans nor slowdowns. The selective integration of GenAI should be implemented in relation to clearly defined learning goals and where human users are still responsible for verifying, interpreting and planning. Teachers "will continue to play the role of instructional designers, disciplinary experts, mentors and evaluators who are held accountable, while students will need to cultivate independent reasoning, critical judgment, and the ability to question automatic outputs. The validity and ethical governance of assessment, professional development and equity of access to GenAI tools will be the foundation of the future contribution of GenAI to education. Educational systems should continue to provide learners with opportunities to make productive cognitive efforts and be equipped to critically and responsibly interact with generative technologies. Finally, GenAI should be leveraged as a tool to enhance—which is not replace—humans' agency, cognitive growth and trustworthy education.

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