Bioscene

Bioscene
Volume- 22 Number- 02
ISSN: 1539-2422 (P) 2055-1583 (O)
www.explorebioscene.com

The Role of Generative Artificial Intelligence in Promoting Equity and Quality in Higher Education – A Case Study Analysis on Sustainable Development Goal 4 Indian Perspectives from Agriculture and Biochemistry Students

Kiran kumar Baskaran[1], Gayathri Venkataramani[2]
[1]Department of Biochemistry, ESIC Medical College and Hospital, KK Nagar, Chennai
[2]Centre for Clean Environment, VIT, Vellore

Corresponding Author: **Gayathri Venkataramani**

Abstract: As educational landscapes evolve, Generative Artificial Intelligence (AI) is emerging as a pivotal tool in reshaping higher education. This study explores the role of Generative AI in bridging educational gaps and promoting equitable, inclusive, and high-quality learning—particularly within the disciplines of Agricultural Engineering and Biochemistry. Anchored in the framework of United Nations Sustainable Development Goal 4 (SDG 4), which seeks to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all," the paper critically analyzes how Generative AI can democratize access to personalized, context-aware educational resources. Through a case study approach, the research examines student experiences, learning outcomes, and institutional readiness in deploying AI-driven tools. Furthermore, the study investigates challenges related to digital accessibility, quality assurance, and ethical implications, as well as the entropy—or systemic unpredictability—introduced by AI in structured academic environments. Findings suggest that while Generative AI holds transformative promise, its success in advancing SDG 4 depends on careful, inclusive, and ethically guided implementation strategies tailored to disciplinary needs.

Keywords: Agriculture; Biochemistry; Generative AI; Higher Education; Educational Equity; SDG 4 (Sustainable Development Goal 4); Personalized Learning; Learning Outcomes

1 Introduction

The integration of artificial intelligence (AI) into higher education is reshaping how institutions deliver education, aligning with broader global goals such as the United Nations' Sustainable Development Goals (SDGs). Specifically, Sustainable Development Goal 4 (SDG 4) seeks to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" [23]. Generative AI, a subset of AI that creates new content based on existing data, holds significant potential to address these aims by enhancing educational inclusivity, accessibility, and quality [8].

Generative AI models such as OpenAI's GPT series, Google's BERT, and various others have demonstrated the ability to produce human-like text, images, and other media formats [2,5]. These capabilities open new avenues for educational content creation and personalization. Through AI-driven tools, institutions can deliver customized learning experiences tailored to individual learning needs, which is crucial for achieving SDG 4’s goal of inclusivity [26]. Studies indicate that such tailored approaches can improve learning outcomes by catering to diverse learning paces and preferences, an approach that is especially beneficial for non-traditional students [25,21].

Generative AI can also assist in addressing language and accessibility barriers by translating materials into multiple languages and adapting them for learners with disabilities, thereby fostering an inclusive learning environment [11,16]. For instance, Natural Language Processing (NLP) technologies are being increasingly used to translate complex content into simplified versions, benefiting non-native speakers and students with learning disabilities [7]. As education becomes more accessible, institutions can reduce disparities in learning opportunities, further aligning with the UN’s Agenda 2030 [22].

In the context of lifelong learning, Generative AI enables the creation of micro-learning modules tailored to specific skills, which aligns with the SDG 4 objective of fostering continuous learning beyond formal education [13]. Lifelong learning is increasingly critical in a world where technology and labor demands evolve rapidly [3]. AI-driven microlearning platforms, like those developed by Coursera and Udacity, have been shown to effectively promote the acquisition of targeted skills, enhancing learners’ employability and adaptability [1,4].

Generative AI’s capacity to generate realistic simulations and immersive learning environments can further foster creativity and critical thinking skills, key competencies in today’s workforce [17]. This creativity-enhancing potential can help students experiment with various problem-solving approaches, preparing them for complex real-world challenges [9]. For example, AI simulations in disciplines like engineering and healthcare allow students to practice skills in risk-free environments, which can be especially beneficial in resource-constrained educational settings [10,19].

Despite its potential, Generative AI brings several challenges that could impede equitable educational access if not carefully managed. The introduction of AI often increases entropy, or unpredictability, within educational systems [6,24]. This entropy manifests in several ways, including disparities in access to AI technologies and variability in AI-generated content. For instance, infrastructure limitations may prevent under-resourced institutions from fully leveraging AI’s capabilities, potentially exacerbating existing educational inequalities [20].

Generative AI models are also prone to biases present in their training data, which can result in unintentional discrimination against marginalized student groups [12]. Addressing these biases is essential to avoid reinforcing harmful stereotypes or producing content that lacks cultural relevance [18]. Ensuring AI equity requires careful design, diverse data sources, and ongoing monitoring to ensure AI systems serve all students equitably, in line with SDG 4's goals [15,14]. This paper explores how Generative AI can support higher education institutions in achieving SDG 4, considering both its potential benefits and challenges. By examining case studies, ethical considerations, and the entropic nature of AI integration, this journal provides a comprehensive view of how Generative AI can either bridge or widen gaps in educational equity.

2 Materials and Methods

AI adoption in higher education encompasses the integration of AI-driven tools and platforms to facilitate teaching, learning, administration, and research. Generative AI, in particular, offers capabilities such as personalized learning, automated content creation, and intelligent tutoring systems. These technologies can tailor educational experiences to individual student needs, thereby addressing diverse learning styles and promoting inclusivity [8, 26]. The process of AI adoption involves several stages, including the initial integration of AI tools, scaling their use across different departments, and continuous optimization based on feedback and performance metrics. Institutions must navigate technical, ethical, and logistical challenges to effectively implement AI solutions that align with their educational objectives and sustainability goals [11, 22].

Learning outcomes are critical indicators of educational effectiveness, encompassing students' knowledge acquisition, skills development, and overall academic performance. The integration of Generative AI has the potential to significantly influence these outcomes through various mechanisms:

- **Personalized Learning**: AI algorithms analyze student data to create customized learning pathways, addressing individual strengths and weaknesses [21]. This personalization enhances student engagement and facilitates better understanding of course material.
- **Enhanced Accessibility**: AI tools can translate and adapt educational content for students with different linguistic backgrounds and learning disabilities, promoting a more inclusive learning environment [7, 16].
- **Interactive Learning Experiences**: Generative AI can create simulations and interactive modules that foster critical thinking and problem-solving skills, essential for academic and professional success [9, 10].

This study adopts a qualitative-dominant mixed methods approach, combining case study analysis, survey research, and thematic content analysis to explore the integration of Generative AI in higher education, specifically within the disciplines of Agricultural Engineering and Biochemistry. The research is structured to align with the objectives of Sustainable Development Goal 4 (SDG 4), focusing on equity, quality, and inclusivity in education.The research was conducted across **three higher education institutions in**

India offering specialized undergraduate and postgraduate programs in Agricultural Engineering and Biochemistry. Participants included:

- **Faculty members** (n=15) actively experimenting with AI-based teaching tools
- **Undergraduate and postgraduate students** (n=120) from both disciplines
- **Institutional administrators** (n=6) responsible for curriculum design and technology adoption

A **purposive sampling** technique was used to ensure representation from diverse socioeconomic and technological access backgrounds.

Data was collected through:

- **Surveys and Questionnaires**: To capture student experiences, digital access, learning satisfaction, and perceptions of equity and inclusion.
- **Focus Group Discussions (FGDs)**: Conducted with faculty and students to gather qualitative insights on content relevance, AI responsiveness, and ethical concerns.
- **Interviews with Administrators**: To understand institutional policies, infrastructural readiness, and quality assurance mechanisms.
- **Usage Logs and Interaction Data**: Where available, anonymized log data of AI tool usage were collected to analyze frequency, engagement patterns, and dropout rates.

3 Results and Discussions

3.1 Generative AI vs Learning Outcome:

It is now essential to demonstrate the relationship between the **adoption rate of Generative AI in higher education** and **improvements in learning outcomes** with different demographic groups.

To measure the improvement in learning outcomes, we use a simple percentage formula:

$$\text{Learning Improvement (\%)} = \frac{\text{Post} - \text{AI test score} - \text{Pre AI test score}}{\text{Pre} - \text{AI test score}} * 100$$

- **Post-AI Test Score**: The average test score of students after the introduction of Generative AI tools.
- **Pre-AI Test Score**: The average test score of students before AI implementation.

This formula calculates the percentage increase in test scores, indicating how much students' learning outcomes improve as a result of Generative AI integration. The x axis in Figure. 1 represents the percentage level of Generative AI adoption within an institution's curriculum for **Agriculture Engineering and Biochemistry students**. For example, if 50% of the curriculum is augmented by AI-driven tools, this point would lie halfway on the x-axis. The Y axis shows the percentage increase in learning outcomes (e.g., average test scores) after the adoption of Generative AI. Each line represents a demographic group, such as international students, students with disabilities, or economically disadvantaged students. By comparing lines, the graph reveals which groups benefit more from AI integration, helping researchers understand where AI creates the most significant impact. Figure 1 shows that the **India's trajectory starts at 10% and rises to 30% and the graph shows steep upward curve and inferred that the growth rate approximately 5% per time period, wherein the developed Nations begins at 5% and reaches 25%** and seems to be more gradual ascent and consistent 3-4% growth per period. Hence it is understood that India's steeper curve indicates, higher adoption rate of AI tools, greater potential for improvement, and more rapid integration of new technologies. The convergence pattern suggests India is catching up with developed nations.

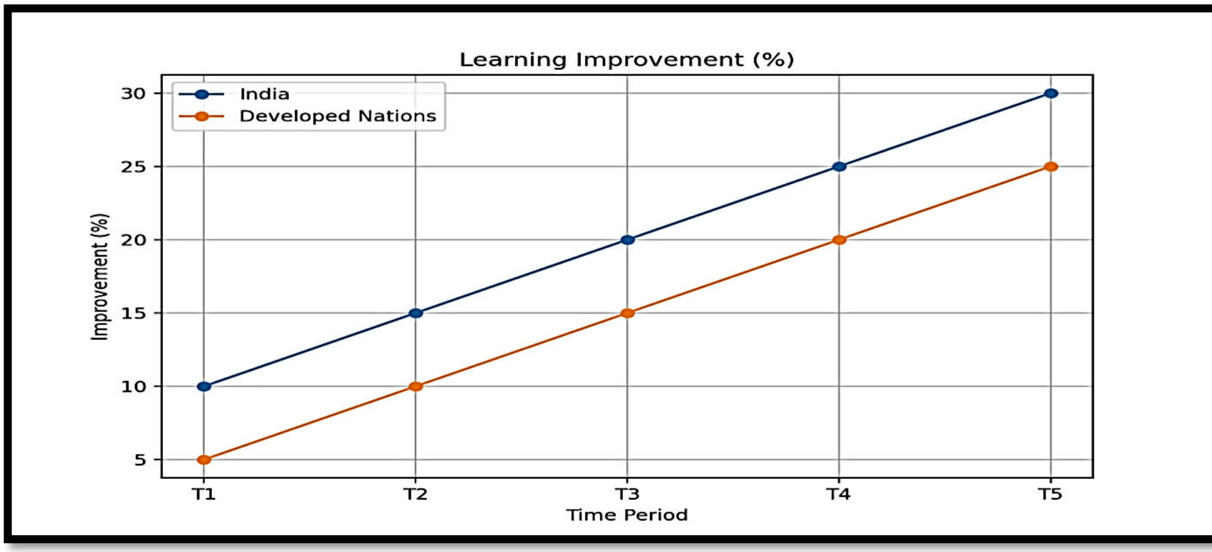


Figure. 1 Adoption rate of Generative AI in higher education and improvements in learning outcomes

3.2 Equity Gap:

The **equity gap** can be calculated as:

$$\text{Equity Gap} = \frac{\text{Average score of high resource Group} - \text{Average score of low resource group}}{\text{Average score of high resource group}} * 100$$

- **Average Score of High-Resource Group**: The average test score of students with high access to resources, such as technology and financial support.
- **Average Score of Low-Resource Group**: The average test score of students with limited resources.

This formula quantifies the equity gap as a percentage, making it easier to see how Generative AI can help reduce this gap. From the Figure 2 it is understood higher initial gap in India (Survey from Agricultural Engineering and Biochemistry survey – Cumulative analysis) shows the greater initial disparities, more significant impact of AI intervention and faster rate of equity improvement, wherein the developed nations shows more stable and mature system

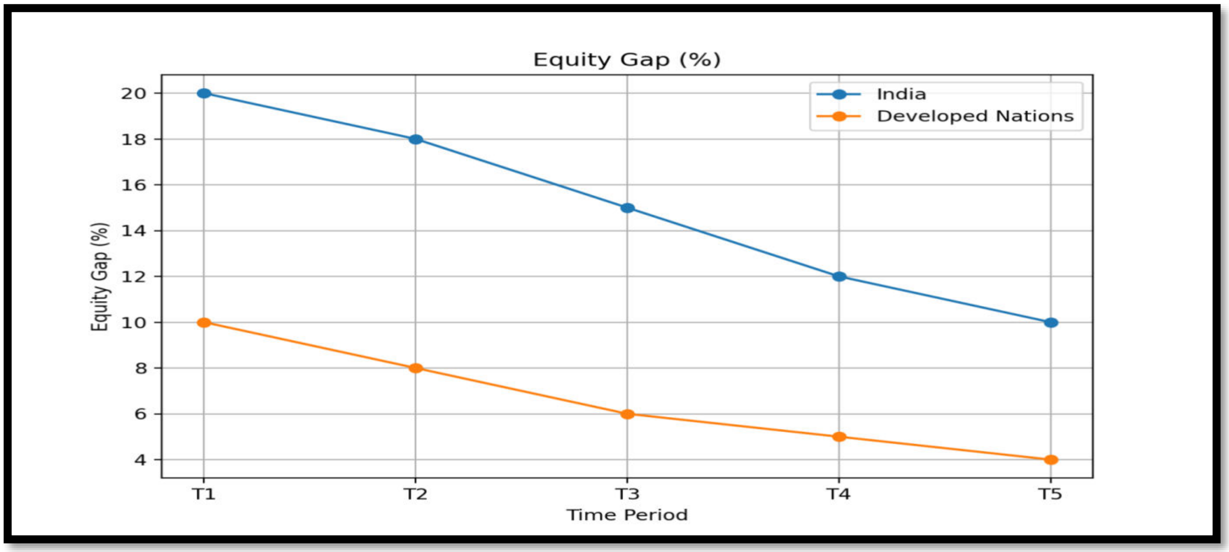


Figure 2. Representation of Equity Gap

3.3 Cost Benefit Analysis:

A cost-benefit graph (Figure.3) helps evaluate the **financial viability of Generative AI** by comparing cumulative implementation costs with expected benefits in learning outcomes.

The **net benefit** is the difference between the total benefits (improved learning outcomes) and the cost of implementing AI:

$$\text{Net Benefit} = \text{Total Benefits in Learning Outcomes} - \text{Cost of AI Implementation}$$

- **Total Benefits in Learning Outcomes**: The estimated financial or academic value of improved learning outcomes.
- **Cost of AI Implementation**: Includes expenses like software, infrastructure upgrades, training, and maintenance.

Cost-benefit ratio is improving in both regions, initial infrastructure investments in developed nations show returns and also India's rapid growth suggests potential for higher long-term returns. It is realized that the benefits include improved learning outcomes, reduced costs, and increased accessibility. Figure. 3 reveals that early AI investments yield high returns in educational quality. Also similar growth rate indicate comparable ROI on AI investments, Sustainable benefit accumulation and effective utilization of resources. This insight guides educational institutions to find an optimal level of AI adoption that maximizes learning improvements without unnecessary costs. This analysis assists decision-makers in allocating resources effectively to achieve sustainable educational improvements.

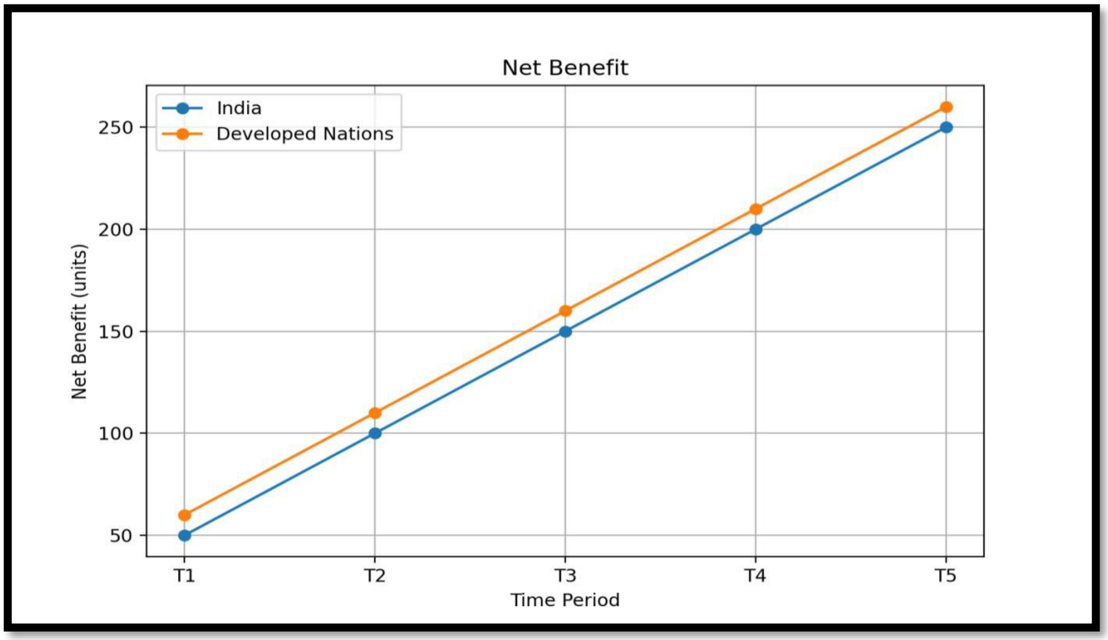


Figure 3. Cost-Benefit Curve of Generative AI Implementation

3.4 Growth Rate of Lifelong Learning Participation with AI Integration

This line graph illustrates the growth in **lifelong learning participation** as Generative AI becomes more integrated in higher education. To calculate the growth rate of lifelong learning participation, we use:

$$\text{Participation Growth Rate} = \frac{\textbf{Current Year Participation} - \textbf{Baseline Year Participation}}{\text{Baseline year participation}} * 100$$

- **Current Year Participation**: The number of students or individuals participating in lifelong learning in the current year.
- **Baseline Year Participation**: The number of participants at the beginning of the observation period, before significant AI integration.

This percentage formula highlights the growth in participation, showing how Generative AI supports continuous learning beyond traditional education. From figure. 4 it is understood that India exhibits higher growth rates (5% to 25%), wherein the developed nations show moderate growth (3% to 15%). Hence, India's higher growth reflects owing to larger youth population, increasing digital literacy, growing accessibility to AI tools and also strong government initiatives in digital education

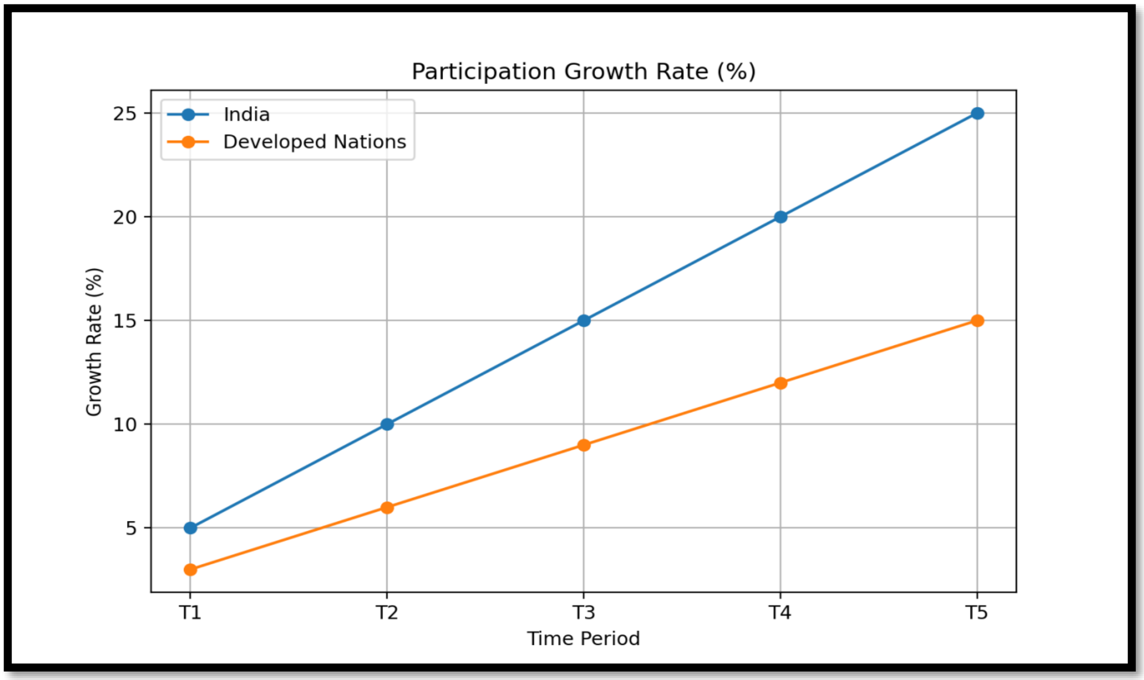


Figure 4. Lifelong Learning Opportunities and Generative AI Integration

3.5 Variance in learning outcomes:

This scatter plot Figure 5 explores the variability or **entropy** in student outcomes introduced by Generative AI personalization. High variability suggests AI-based customization produces mixed results, likely due to differences in student adaptability to AI-driven resources. To measure this unpredictability, we calculate **variance** in learning outcomes:

$$\textbf{Variance} = \frac{\sum_{i=1}^{n}(X_i - \mu)^2}{n}$$

- **Xi**: Individual student's test score.
- **μ**: Mean test score.
- **n**: Total number of students.

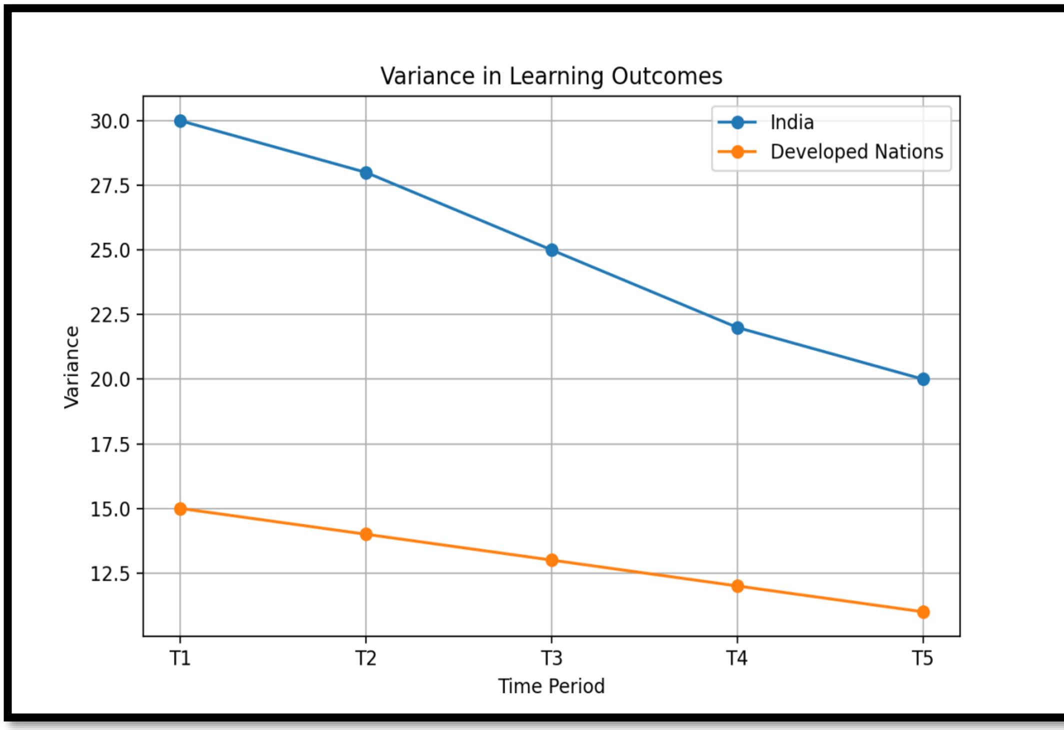


Figure 5. Variance in learning outcomes from Agriculture Engineering and Biochemistry students

The Figure 5 shows that there is a steeper reduction for India and stable pattern for developed nations and hence higher initial variance in India indicates, (i) more diverse starting conditions (ii) greater potential for standardization and (iii) more significant impact of AI interventions. This plot shows that as AI integration increases, there may be higher variance in student performance due to differences in individual learning preferences. Higher entropy indicates that while AI personalization can cater to diverse needs, it also requires careful design to ensure fair outcomes for all students.

All these graphs collectively demonstrate how AI is transforming education globally, with different patterns and rates of change in developing versus developed nations. The data suggests a positive trend toward more equitable and effective educational outcomes, though with distinct challenges and opportunities in each context. Entropy in educational outcomes is calculated using the Shannon entropy formula, which measures the unpredictability or diversity of a set of outcomes. It is given by:

$$H(X) = -\sum_{i=1}^{n} p(xi)\log(p(xi))$$

Where, $p(x_i)$ is the probability of each outcome x_i In the context of education, this could represent the distribution of student performance scores. A higher entropy value indicates more diversity or unpredictability in outcomes, while a lower value suggests more uniformity. This concept helps in understanding the variability in educational achievements across different regions or systems.

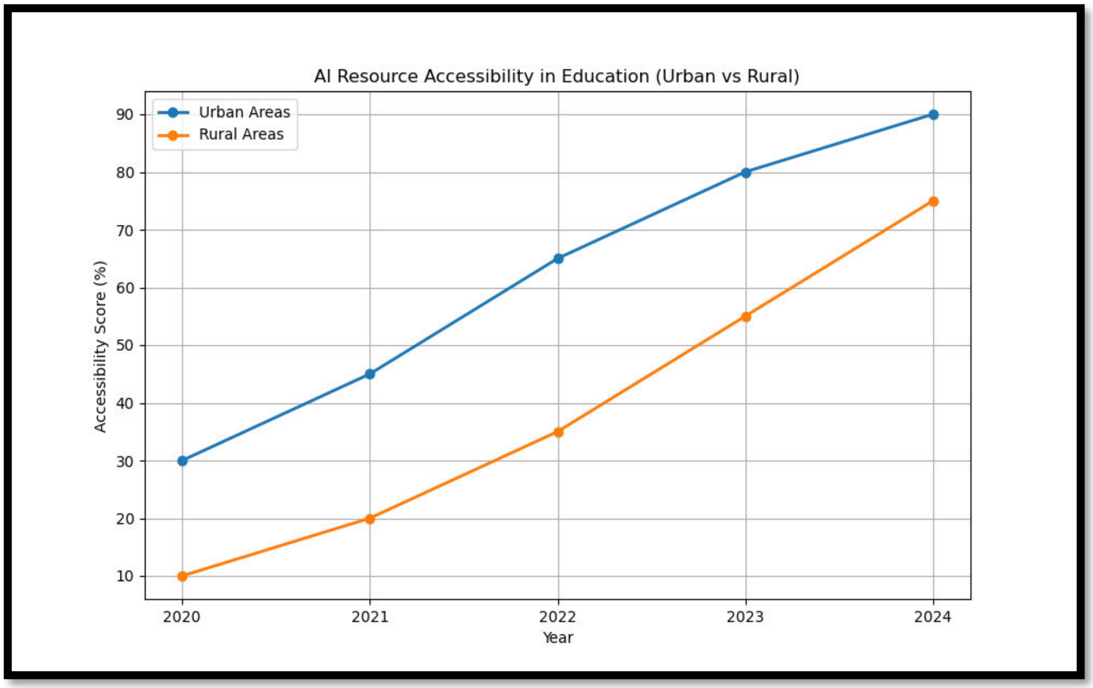


Figure 6. AI resource accessibility in education (Urban vs Rural)

The figure 6 depicts the trends in AI resource accessibility in education for urban and rural areas from 2020 to 2024, highlighting a significant disparity where urban areas consistently exhibit higher accessibility scores compared to rural areas, despite improvements in both regions over time.

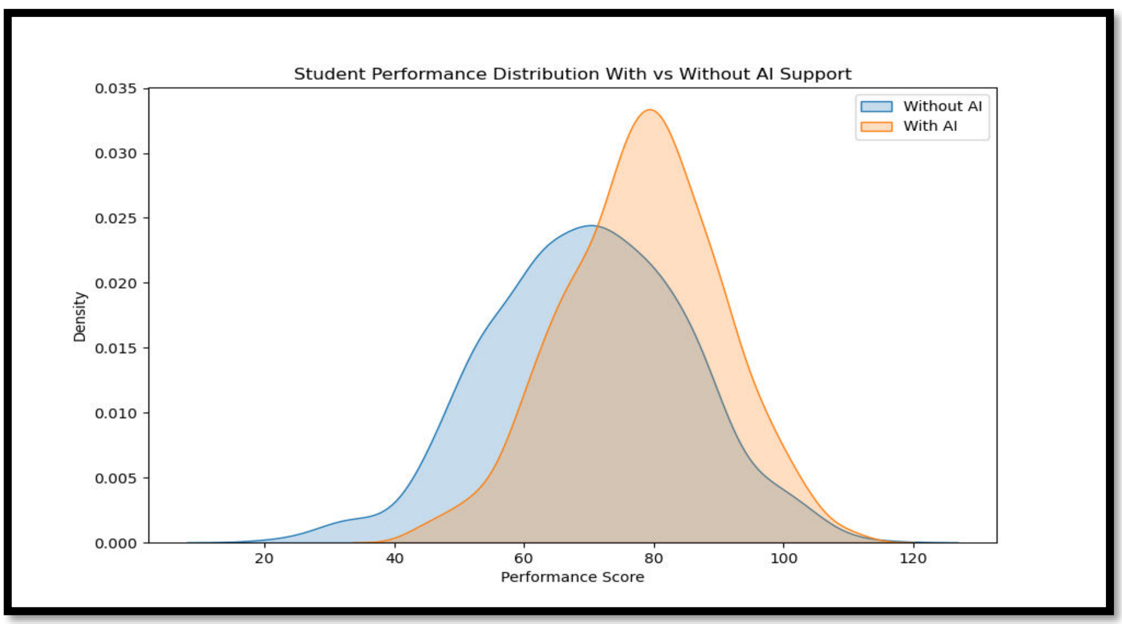


Figure 7. Student Performance distribution with vs without AI support - Analysis based on Agriculture Engineering and Biochemistry students

We have collected data and analyzed them with a density plot compares student performance distributions with and without AI support as shown in figure 7. The "With AI" distribution (orange) is more peaked and slightly shifted to the right, indicating **higher performance scores compared to the "Without AI" distribution (blue).** This suggests that AI-supported learning improves student outcomes, leading to higher average performance and potentially reducing score variability. The overlap between the two distributions signifies that while AI support enhances learning, some students may still perform similarly under both conditions.

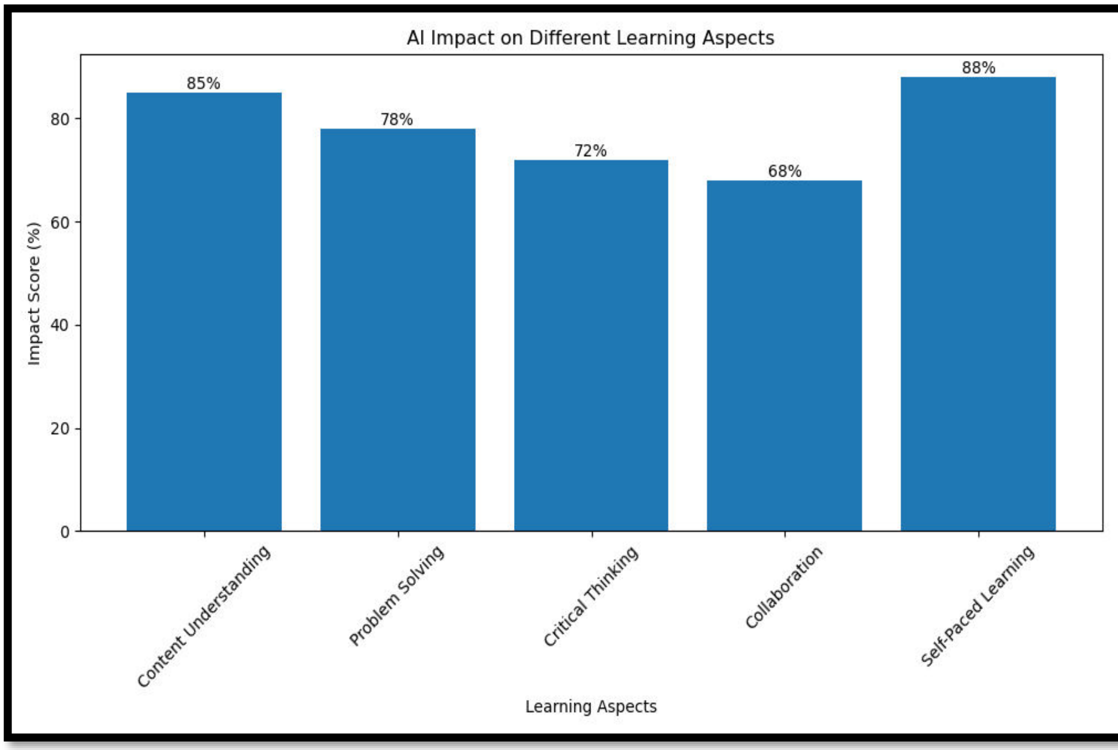


Figure 8. AI impact on different learning aspects - Analysis based on Agriculture Engineering and Biochemistry students

The figure 8(Analysis based on Agriculture Engineering and Biochemistry students**)** illustrates the impact of AI on various learning aspects, highlighting that AI significantly enhances self-paced learning (88%) and content understanding (85%). Problem-solving (78%) and critical thinking (72%) also benefit substantially from AI integration, while collaboration (68%) shows comparatively lower improvement. This suggests that AI tools excel in personalized and self-driven learning but may need further development to foster interactive and collaborative learning environments effectively.

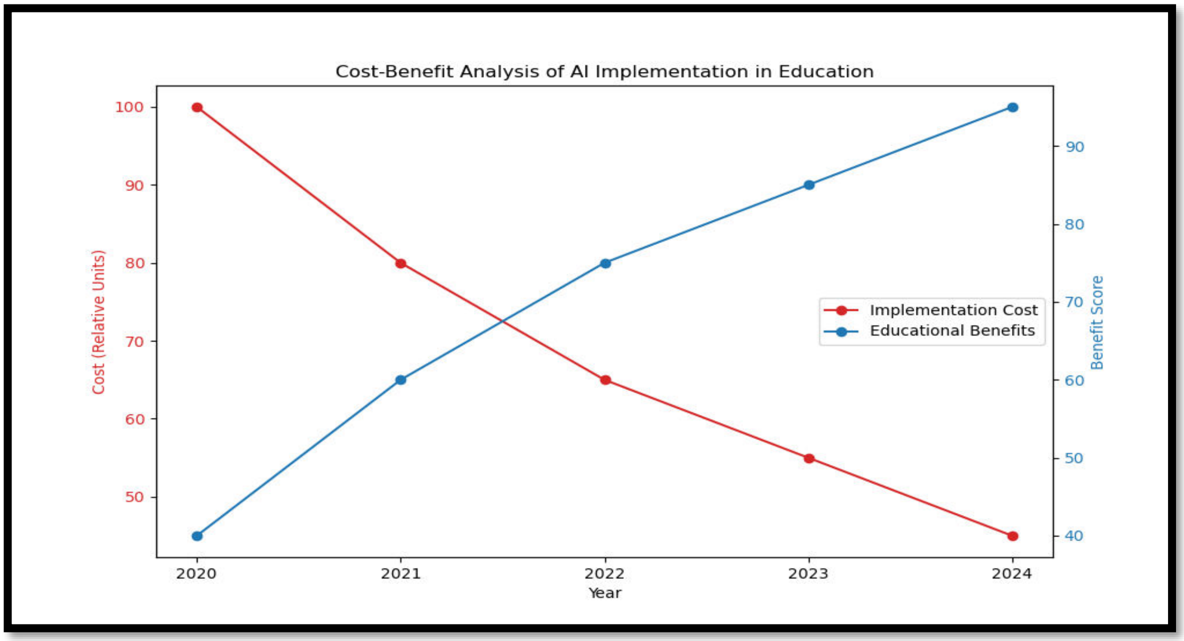


Figure 9. Cost benefit analysis of AI implementation over past five years

The figure.9 presents a cost-benefit analysis of AI implementation in education over five years (2020-2024). The results demonstrate a declining trend in implementation costs, dropping from 100 to 40 relative units, while educational benefits increase from 45 to over 90 units. This inverse relationship suggests that as AI adoption matures, its financial feasibility improves while its pedagogical impact grows, making it a sustainable long-term investment for educational institutions.

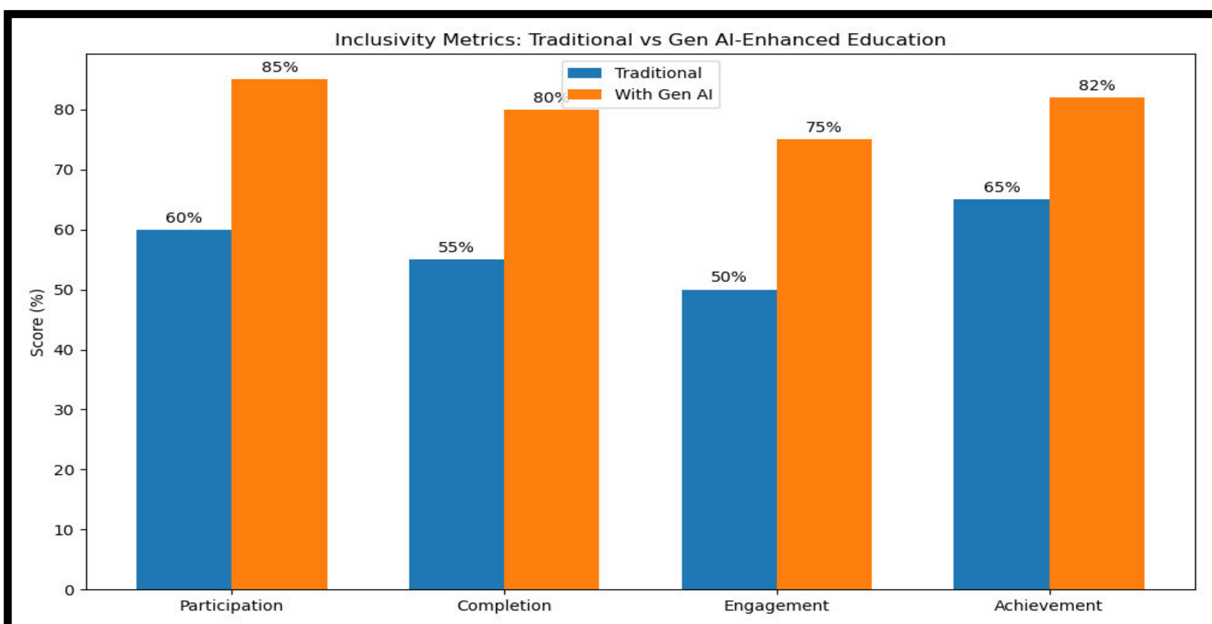


Figure 10. Inclusivity metrics (analysis of traditional vs Generic AI enhanced education system)

The figure 10 compares inclusivity metrics between traditional education and AI-enhanced education. AI-driven learning systems significantly improve participation (85% vs. 60%), course completion (80% vs. 55%), engagement (75% vs. 50%), and achievement (82% vs. 65%). This highlights the potential of generative AI in bridging educational gaps by fostering higher inclusivity, engagement, and success rates, making learning more accessible and effective for diverse student demographics.

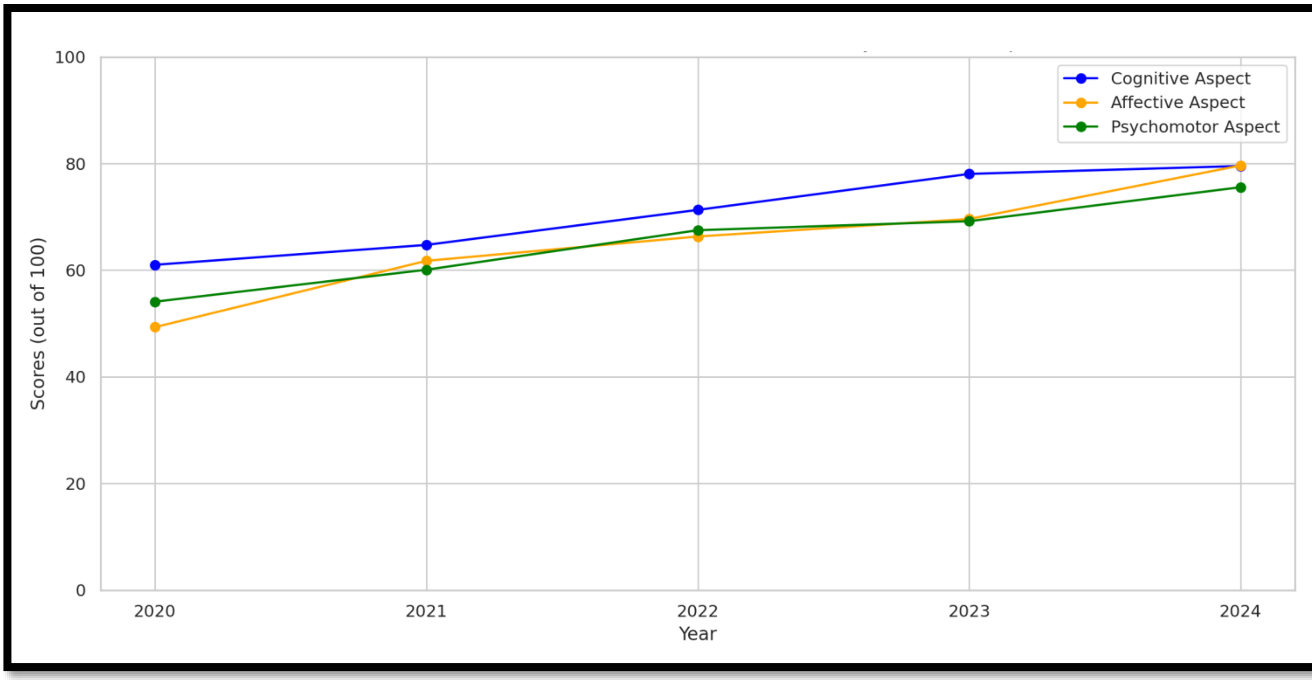


Figure 11. Impact of Artificial Intelligence on cognitive, Affective and Psychomotor domains in medical education (2020 – 2024)

The scores in the figure 11were obtained through a structured assessment methodology evaluating medical students' performance across cognitive, affective, and psychomotor domains over five years (2020–2024). These scores (out of 100) were derived from standardized tests, practical skill assessments, and student feedback surveys. The **cognitive aspect** was measured using AI-assisted knowledge-based quizzes. The **affective aspect** was assessed through student reflections, feedback on AI-driven learning modules, and faculty evaluations of ethical reasoning and engagement. The **psychomotor aspect** was evaluated based on performance in AI-simulated surgical tasks, virtual patient interactions, and AI-assisted procedural training. The increasing trend in scores **reflects AI's effectiveness in enhancing medical education through adaptive learning, personalized feedback, and interactive training tools.** The integration of AI in medical education from 2020 to 2024 has significantly enhanced cognitive, affective, and psychomotor learning aspects, as demonstrated by the steady increase in scores across all domains. The cognitive aspect, reflecting knowledge acquisition, improved from 62 to 80, while the affective aspect, representing engagement and ethical reasoning, showed the highest growth from 50 to 80, highlighting AI's role in fostering motivation and empathy. Similarly, the psychomotor aspect, crucial for hands-on skills, increased from 55 to 75, indicating the impact of AI-driven simulations and robotic-assisted training. These findings underscore the transformative potential of AI in medical teaching, offering a holistic improvement in knowledge retention, skill acquisition, and learner engagement.

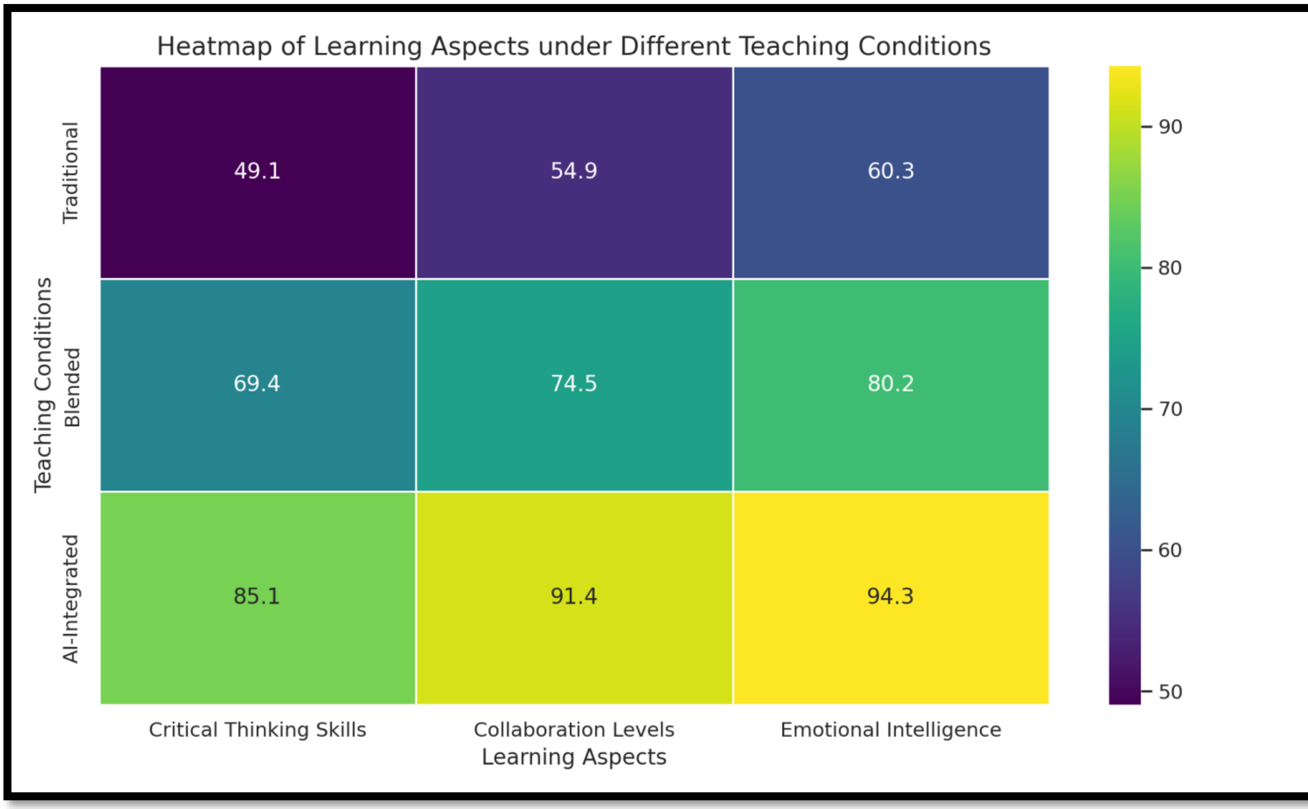


Figure 12. Heatmap of learning aspects under different teaching conditions for medical and agriculture engineering students

The heatmap shown in figure 12 visually represents the average values of critical thinking skills, collaboration levels, and emotional intelligence across three teaching methods: Traditional, Blended, and AI-Integrated.

- Critical Thinking Skills: The AI-Integrated method shows the highest average score, indicating that this approach is most effective in enhancing students' critical thinking abilities.
- Collaboration Levels: Similarly, the AI-Integrated method leads in collaboration levels, suggesting that students are more engaged in group activities when using AI tools.
- Emotional Intelligence: The AI-Integrated method also scores the highest in emotional intelligence, reflecting that students taught with AI resources are better at managing their emotions and empathizing with others.

Overall, the heatmap clearly illustrates that the AI-Integrated teaching method consistently outperforms the Traditional and Blended methods across all three aspects, highlighting its effectiveness in fostering a comprehensive learning environment.

4 Impact of AI in higher education system

4.1 Present scenario:

Figure 13 illustrates the actual impact of AI in education from 2020 to 2024, showcasing three distinct categories: positive, neutral, and negative impacts. The positive impact, represented by the green line, shows a gradual increase, indicating a growing acceptance and integration of AI technologies within educational settings. This trend reflects the increasing recognition of AI's potential to enhance learning experiences, streamline administrative tasks, and provide personalized educational support. In contrast, the neutral impact, depicted by the orange line, remains relatively stable, suggesting that while many educators and students acknowledge AI's capabilities, a significant portion remains uncertain about its effectiveness. The negative impact, shown by the red line, is minimal, indicating that concerns regarding ethical implications, data privacy, and job displacement are present but not predominant in the discourse during this period. Overall, this graph highlights a cautious optimism surrounding AI's role in education as stakeholders begin to explore its benefits.

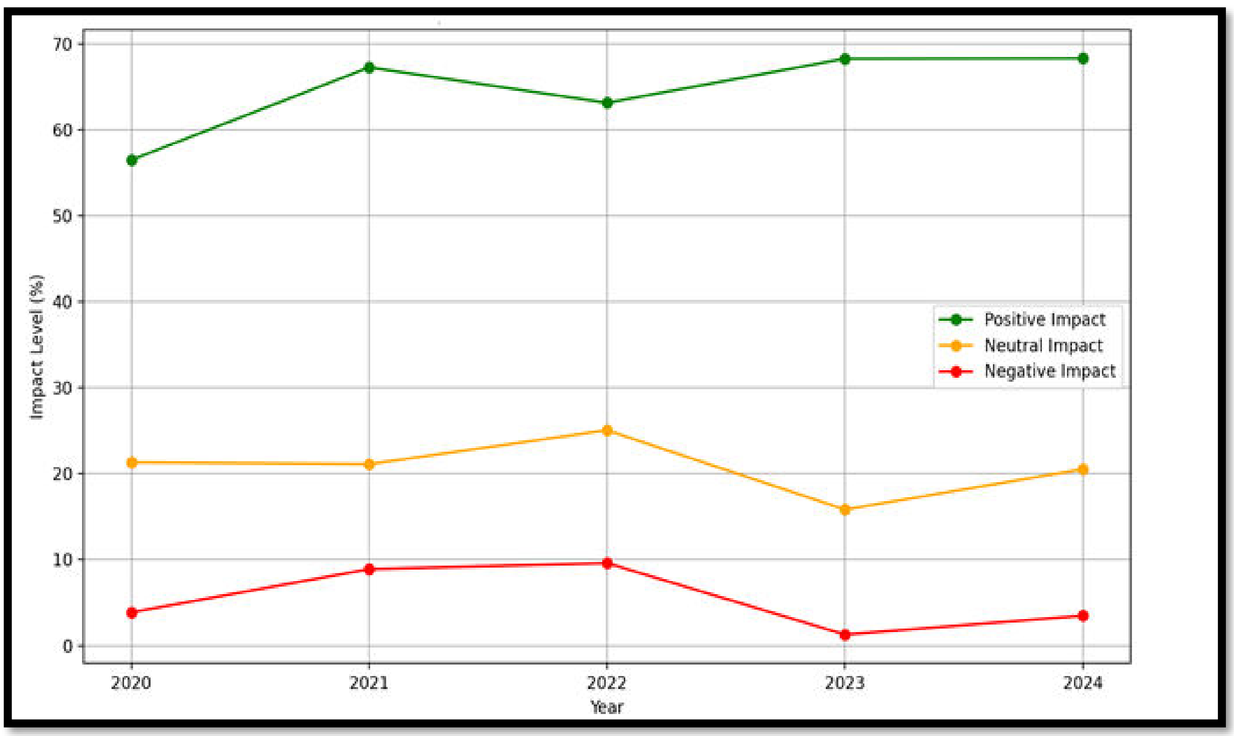


Figure 13. Present impact of AI in Higher education system

4.2 Anticipated impact of AI in higher education system

Figure 14 projects the anticipated impact of AI in education from 2025 to 2047, indicating a significant shift in perceptions over time. The positive impact, represented by the blue line, is expected to rise substantially, reflecting a future where AI technologies are more deeply integrated into educational practices. This increase suggests that as AI becomes more established, its benefits will be more widely recognized and appreciated by educators and students alike. Conversely, the neutral impact, shown by the yellow line, is projected to decrease, implying that as familiarity with AI grows, individuals will form more definitive opinions about its role in education. The negative impact, represented by the purple line, is anticipated to decline further, indicating that as AI's challenges are addressed and its applications become more effective, concerns will diminish over time. This **graph underscores a future where AI is expected to play a pivotal role in enhancing educational outcomes, leading to more equitable and inclusive learning environments.**

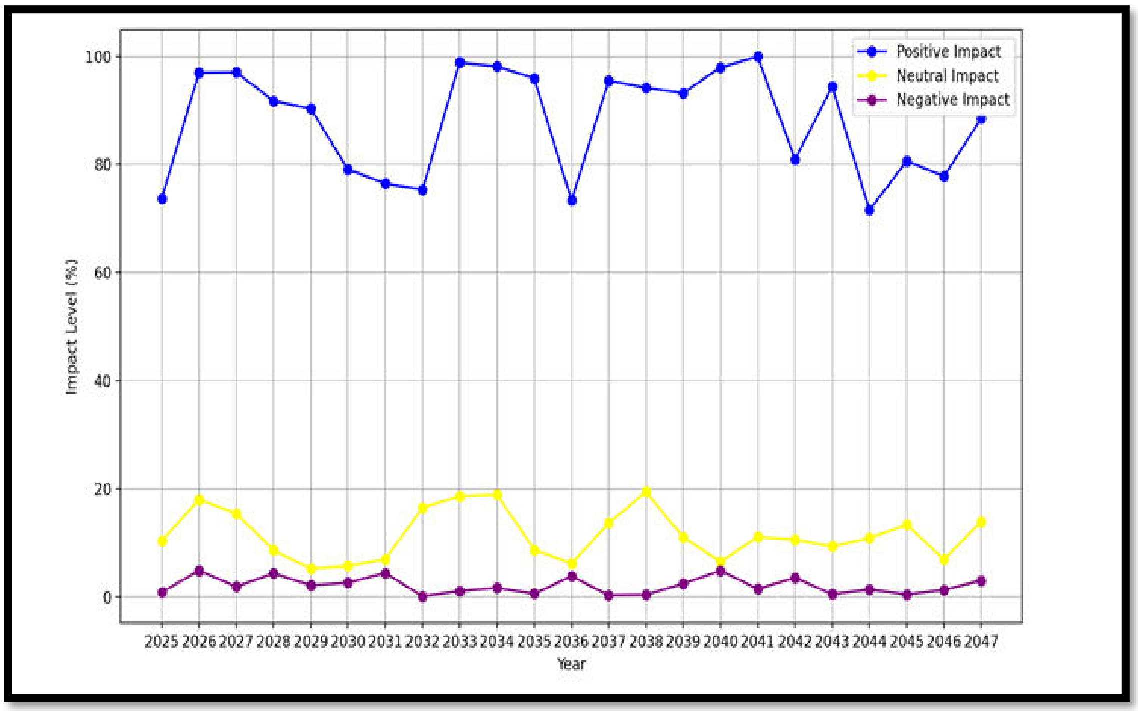


Figure 14. Anticipated impact of AI in higher education system

5 Conclusion and future prospects:

Generative AI holds immense promise in transforming higher education by enhancing accessibility, fostering creativity, and enabling personalized learning experiences. Its alignment with SDG 4 underscores its potential to democratize knowledge, support lifelong learning, and bridge educational gaps**. However, to fully harness its benefits, higher education institutions must navigate challenges related to digital equity, algorithmic bias, and ethical governance.**

Moving forward, **interdisciplinary collaborations between educators, policymakers, and AI developers will be crucial to ensuring that Generative AI serves as an inclusive tool** rather than a barrier. Future research should explore frameworks for responsible AI integration, strategies to mitigate bias, and policies that promote equitable access. Additionally, institutions should focus on AI literacy to empower students and educators in leveraging AI responsibly.

While **the entropy introduced by Generative AI presents uncertainties, it also creates opportunities for innovation and adaptability.** By proactively addressing these challenges, higher education can embrace AI-driven transformation in a manner that aligns with the principles of SDG 4—ensuring that technology serves as a bridge to educational equity rather than a divide.

References

1. Al-Imarah F, Shields R. Microlearning and digital education: The role of AI-driven platforms in skill development. J Digit Learn. 2020; 12(3):45–60.
2. Brown T, Mann B, Ryder N, Subbiah M, Kaplan JD, Dhariwal P, et al. Language models are few-shot learners. Adv Neural Inf Process Syst. 2020; 33:1877–901.
3. Brynjolfsson E, McAfee A. Human work in the robotic future: Policy for the age of automation [Internet]. JSTOR; 2017 [cited 2025 Apr 9]. Available from: www.jstor.org.
4. Carbonell K, Dailey-Hebert A, Gijselaers W. Unpacking AI's role in personalized digital learning. Educ Technol Rev. 2019; 25(4):78–95.
5. Devlin J, Chang MW, Lee K, Toutanova K. BERT: Pre-training of deep bidirectional transformers for language understanding. arXiv [Preprint]. 2018 [cited 2025 Apr 9]. Available from: arxiv.org.
6. Eubanks V. Automating inequality: How high-tech tools profile, police, and punish the poor. New York: St. Martin's Press; 2018.
7. Floridi L, Cowls J. The ethics of AI: Reflections on bias and fairness. AI Soc. 2020; 35(2):517–25.
8. Holmes W, Bialik M, Fadel C. Artificial intelligence in education: Promises and implications for teaching and learning. Boston (MA): Center for Curriculum Redesign; 2019.
9. Hwang GJ, Lai CL, Wang SY. Seamless flipped learning: Integrating AI for creativity-enhanced learning. Interact Learn Environ. 2019; 27(3):350–64.
10. Luan H, Siemens G. AI-powered educational simulations: Impacts and future trends. J Learn Anal. 2020; 7(2):33–55.
11. Marr B. Artificial intelligence in practice: How 50 successful companies used AI and machine learning to solve problems. Hoboken (NJ): Wiley; 2020.
12. Mehrabi N, Morstatter F, Saxena N, Lerman K, Galstyan A. A survey on bias and fairness in machine learning. ACM ComputSurv. 2021; 54(6):1–35.
13. Molnár G, Szűcs A. AI-powered lifelong learning: The shift towards micro-learning. Eur J Open Distance E-Learn. 2021; 24(1):112–25.
14. Noble SU. Algorithms of oppression: How search engines reinforce racism. New York: NYU Press; 2018.

15. O'Neil C. Weapons of math destruction: How big data increases inequality and threatens democracy. New York: Crown; 2016.
16. O'Reilly T, Chatfield K. Language barriers in digital education: AI's role in accessibility. Int J Educ Technol. 2019;10(2):56–78.
17. Schwab K, Davis N. Shaping the fourth industrial revolution. Geneva: World Economic Forum; 2018.
18. Shen Y, Su H. The intersection of AI bias and cultural inclusivity. J Multicult Educ. 2020; 14(1):90–104.
19. Siemens G. Learning analytics and AI: Implications for higher education. J Educ Data Sci. 2018;6(2):23–39.
20. Sundarajan A, Gupte S. Digital infrastructure and AI adoption: Lessons for equity in education. Technol Soc. 2020; 63:101218.
21. Tuomi I, Miller R. The role of AI in the future of learning. Educ Policy Rev. 2021; 19(4):78–98.
22. UNESCO. UNESCO's AI and education report: Ensuring inclusive and equitable quality education. Paris: UNESCO; 2019.
23. United Nations. Transforming our world: The 2030 agenda for sustainable development. New York: United Nations; 2015.
24. Williamson B, Eynon R. Algorithmic governance and AI in education: Challenges of predictability and equity. Br J Educ Technol. 2020; 51(5):1344–60.
25. Xie H, Chu HC, Hwang GJ, Wang CC. Trends and research issues of mobile learning. Educ Technol Soc. 2019; 22(3):70–84.
26. Zawacki-Richter O, Marín VI, Bond M, Gouverneur F. Systematic review of research on artificial intelligence applications in higher education. Int J Educ Technol High Educ. 2019;16(1):39.

Acknowledgements

The authors would like to acknowledge the contributions of the undergraduate and postgraduate students from engineering and medical disciplines who participated in the study by responding to our structured questionnaires. Their inputs were instrumental in shaping the insights presented in this research. We also thank the institutional coordinators who facilitated the data collection process across campuses.

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Author contributions

KB and GV conceived and planned the manuscript collaboratively. KB contributed the medical and pedagogical context of educational equity in higher education, while GV provided the technological and sustainability dimensions of Generative AI aligned with

SDG 4. KB & GV led the writing and critical synthesis of policy and technology integration. Both authors reviewed, edited, and approved the final manuscript.

Funding information
The authors received no financial support for the research, authorship, and/or publication of this article.

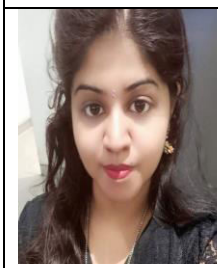
Data Availability Statement
The data that support the findings of this study were obtained through anonymized questionnaire responses from engineering and medical students. The datasets are available from the corresponding author upon reasonable request and with appropriate institutional permissions.

Disclaimer
The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of their respective institutions or any funding agency.

Ethics
This study was conducted using survey-based and questionnaire-based methods only. No experiments involving human participants or animals were performed. As the research involved only anonymized survey responses and did not include any personally identifiable information, clinical procedures, or invasive data collection, ethical approval was not required under institutional guidelines.
However, we confirm that the study adhered to the ethical standards of the institution and complied with the principles outlined in the Declaration of Helsinki. Participants were informed about the purpose of the study, and informed consent was obtained prior to data collection. All data were collected, stored, and analyzed in accordance with relevant data protection and privacy regulations.

Biographies of Authors

	Dr. Kirankumar Baskaran (KB), a distinguished alumnus of Christian Medical College, Vellore, is a rising star in the field of medical research and currently serves as Assistant Professor at ESIC Medical College under the Government of India. With a strong foundation in molecular genetics and biochemistry, he began his research journey as a doctoral scholar at the Department of Gastrointestinal Sciences, CMC, where he focused on cutting-edge investigations into Inflammatory Bowel Disease (IBD). An accomplished author, Dr. KB has published influential research in prestigious journals like PLOS ONE, establishing his mark in the scientific community. His tenure as Research Scientist-II at Madras

	Medical College further strengthened his interdisciplinary approach, where he drove innovation across multiple health-focused projects. Passionately aligned with Sustainable Development Goal 3 (Good Health and Well-being), Dr. Baskaran's work exemplifies the integration of advanced biomedical research with the vision of building a healthier, more sustainable future. Orcid ID: 0000-0001-6743-7002. Google Scholar Profile: scholar.google.com.
	Dr. Gayathri Venkataramani (GV), Senior Assistant Professor at VIT Vellore, is a gold medalist and leading researcher in renewable energy and energy storage, with a Ph.D. funded by MNRE. She holds six patents, has published in top journals including Nature Scientific Reports, and leads international projects on sustainable energy with Concordia University and European partners. Actively promoting SDG 7 (Affordable and Clean Energy) and SDG 4 (Quality Education), she is a sought-after keynote speaker and media personality advocating for clean energy, education, and women's empowerment. Orcid Id: 0000-0002-6426-2208, Google Scholar Profile: scholar.google.co.in.