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Application of GenAI in Outcome-Based Education in Teaching Learning Processes

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Abstract

An example of a revolutionary shift in higher education in India is the integration of Generative Artificial Intelligence (GenAI) into the Outcome-Based Education (OBE) framework. National organizations like All India Council for Technology and Education (AICTE), National Board of Accreditation (NBA), and National Assessment and Accreditation Council (NAAC) for accreditation and quality assurance encourage Indian engineering colleges to use learner-centred and data-driven methods for learning and continuous improvement of students. Every stage of the educational cycle, from curriculum design to evaluation and documentation, could benefit from the use of GenAI technologies, such as Large Language Models (LLMs), content generation systems, and adaptive learning platforms. In addition to providing applications for teaching, assessment, research, and accreditation, the paper addresses how GenAI technologies complement and enhance the AICTE-NBA-NAAC ecosystem in higher education. This paper also provides some of the major issues with data integrity, ethical considerations, and faculty awareness, and suggests ways to advance responsible AI use in higher education.

Keywords: Generative artificial intelligence, Large language models, Outcome-based education, Accreditation, Higher education.

1 | Introduction

In India, Outcome-Based Education (OBE) has evolved into a defining paradigm for engineering education. OBE would connect institutional inputs to observable learning outcomes that reflect the competencies that students acquire throughout their academic journey, in contrast to traditional input-based systems that place an emphasis on content delivery. National Board of Accrediation (NBA) [1], Spady [2], statutory organizations like All India Council for Technology and Education (AICTE) and quality assurance organizations like NBA

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and National Assessment and Accrediation Council (NAAC), which require the methodical mapping of COs, POs, and PSOs, serve as guidelines for the implementation of OBE in India [3], [4].

The most recent technological development that has the potential to drastically alter the OBE landscape is Generative Artificial Intelligence (GenAI). Personalized learning experiences, data analysis support, and content creation automation are all possible with Large Language Models (LLM)-based tools like ChatGPT, Gemini, and Copilot [4], [5]. The NBA's emphasis on data-driven analytics, continuous improvement, and documentation of outcome attainment aligns with the integration of GenAI into higher institutions in India.

This article explores the interaction between GenAI and OBE in Indian engineering colleges operating within the regulatory frameworks laid down by AICTE, NBA, and NAAC. While doing so, it engages with theoretical underpinnings, pedagogic benefits, applications, challenges, and prospects with a discussion based on the requirements of accreditation and quality assurance mechanisms.

2 | Literature Review

Research on OBE in Indian engineering institutions has rapidly developed over the last two decades. Various studies point out that OBE frameworks ensure systematic curriculum development and evaluation with defined, achievable learning outcomes for students. Similarly, the tiered accreditation provisions of NBA attach OBE to every course and program through specific graduate attributes.

Meanwhile, generative AI has emerged as a disruptive educational technology. LLMs can produce text indistinguishable from that written by humans and synthesize knowledge to assist with cognitive tasks of summarizing, explaining, and designing learning content-e.g., Zawacki-Richter et al. [6] and Dwivedi et al. [5]. When connected with OBE, GenAI also holds the promise to help automate processes such as curriculum mapping, assessment construction, and feedback, at least to some extent, towards desired learning outcomes [7].

Several international studies are focused on exploring the role of AI in personalized learning and assessment analytics. Chen et al. [9] and Qadir et al. [9] cited that AI-driven analytics improve educational quality by identifying gaps in learner instruction and personalized content delivery. Indian research by Phung et al. [11] further enumerated that the adoption of AI in OBE enhances academic documentation, CO-PO mapping, and report generation for NBA and NAAC assessments. Kim [11] and Zhang et al. [13] found that integration of AI tools increases the transparency and efficiency of OBE in technical education in India. Further, Luckin and Holmes [13] and Nguyen [14] emphasise that the ethical issues and plagiarism are the critical challenges due to the use of AI tools (*Table 1*).

Table 1. Mapping of generative AI applications to OBE components.

OBE Component	Traditional Approach	AI-Enhanced Approach	Outcome
Curriculum design	Manual CO-PO mapping using Bloom's taxonomy	Automated CO-PO-PSO mapping via AI-based taxonomy classifiers	Consistency and speed in curriculum planning
Teaching-learning process	Faculty-centered instruction	AI-generated adaptive content and simulations	Personalized, student-centric learning
Assessment	Manual question paper and rubric creation	Generative AI-based formative and summative assessment generation	Valid and diversified assessment tools
Feedback and attainment	Manual data entry and report preparation	Automated data analytics and outcome attainment reports	Real-time continuous improvement

3 | Generative Artificial Intelligence and Outcome-Based Education

The concept of GenAI in higher education goes beyond simple automation; it involves the ability of AI systems to facilitate personalized pedagogy, simulate cognitive reasoning, and engage in co-creation. Three

dimensions (design, delivery, and documentation) are used by Kasneci et al. [4] to conceptualize GenAI's role in an OBE framework.

3.1 | Design Phase

While curriculum design, GenAI tools could be used to define and map the outcomes of a particular content as per Bloom's taxonomy levels, which reduces the workload of the faculty members. We can use GenAI to establish the relationships among CO-PO mapping, PO-PSO mapping, and CO-PEO mapping as per the NBA and NAAC accreditation processes. For example, ChatGPT can generate sample course outcomes of "heat transfer" for a mechanical engineering course using words such as remember, understand, apply, analyse, evaluate, and create as per Bloom's taxonomy, which is mapped to PO1 (engineering knowledge), PO2 (problem analysis), and PO3 (design/development of solutions) [1].

3.2 | Delivery Phase

GenAI personalizes the educational content in the teaching-learning process by following the instructions of the individual learners. By the implementation of a reinforcement learning algorithm in adapting learning systems to dynamically regulate the content difficulty level and student performance based on slow and fast learners. AI-driven simulators and virtual laboratory facilities also help in visualising and understanding the complex engineering content, which means they enhance the conceptual clarity.

According to Jeet et al. [15], GenAI helps to enable the creation of multilingual content, which is vital in India's diverse linguistic ecology and promotes inclusivity within engineering classrooms. It can also generate contextual examples, lab manuals, and case studies relevant to local industries, thereby enhancing the "relevance" criterion embraced in NAAC assessments.

3.3 | Documentation Phase

Data management and documentation are the most important components of OBE implementation. GenAI automatically generates the reports, correlation matrices, and graphical representation of CO-PO attainment [11] as per the Self-Assessment Report (SAR), which is prescribed by NBA and NAAC, along with the outcome-based curriculum design guidelines issued by AICTE.

Automation helps in end-to-end data tracking, which is very important during visits by NBA and NAAC accreditation teams. GenAI minimizes human error in documentation and analysis, making outcome reports more accurate, reliable, and transparent.

4 | Applications of Artificial Intelligence in Outcome-Based Education Implementation

OBE implementation in engineering colleges can incorporate generative AI at various stages. Curriculum planning, teaching support, assessment, feedback analysis, accreditation management, and research enhancement are the six domains under which applications fail.

4.1 | Curriculum Planning and Outcome Mapping

AI systems evaluate the current curriculum and recommend improvements to bring it into line with national graduate characteristics. This involves generating course articulation matrices and mapping them to the requirements of the AICTE model curriculum. For example, the automated creation of Bloom's taxonomy levels will improve the academic design process and lessen subjectivity [16].

4.2 | Teaching and Learning Support

GenAI applications help in real-time teaching assistance, like lecture notes, summaries, and visual explanations of the content. According to Kasneci et al. [4], it also allows instructors to create multiple

pedagogical resources for different learning platforms. AI tutors are capable of simulating asking students a series of open-ended questions about a specific topic or issue. encouraging critical thinking among students.

The feedback mechanisms of AI are also able to record and analyse the participation of students in their academic laboratory sessions and project reviews. This ensures that the evaluation is evidence-based, which is an important component of the NBA's continuous improvement cycle.

4.3 | Assessment and Evaluation

Assessment is an important component of OBE. Every CO has to be reflected in the question paper. Generative AI is able to create question banks that are tagged with Bloom's levels and mapped outcomes [17]. Automated grading tools can grade descriptive answers, design solutions, or code submissions [7].

Moreover, GenAI has the capacity to automatically create formative assessments, case-based assessments, and design problems specific to each outcome. This decreases faculty workload while increasing the validity and diversity of assessment instruments.

4.4 | Feedback Analysis and Continuous Improvement

AI analytics has the capacity to process large volumes of student feedback and extract from it actionable insights that help improve the teaching-learning process. It also has a sentiment analysis that shows areas where learners are facing difficulty.

Apart from that, AI–based dashboards can visualize the attainment data over a semester, which helps the coordinators to prepare continuous improvement reports that are required for NBA and NAAC.

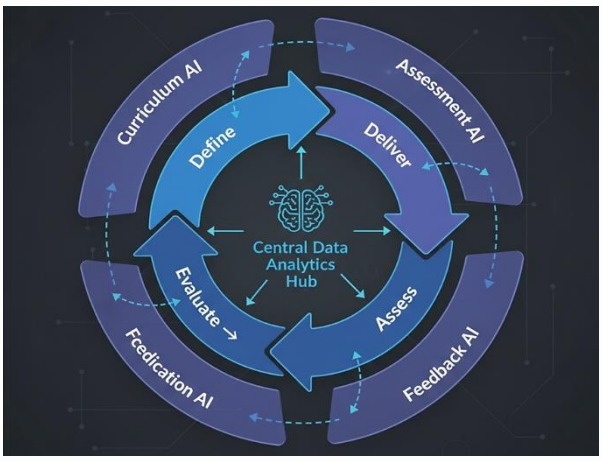

Fig. 1. Conceptual model of an AI-enabled OBE ecosystem.

Fig. 1 describes a circular OBE cycle that has the components defined: deliver, assess, evaluate, and improvement of the cycle, which depend on the above, enhanced by GenAI layers, curriculum AI, assessment AI, feedback AI, and accreditation AI, interconnected through a central data analytics hub.

5 | Benefits and Institutional Impact

GenAI implemented in OBE to improve classroom-level pedagogical innovation to institutional-level accreditation and enhance the quality of assurance mechanisms. With the help of the above mechanisms, enhance the teaching-learning process, reduce academic and operational workload, and strengthen the internal quality assurance in higher education.

5.1 | Pedagogical Benefits

GenAI supports personalized and adaptive learning by analyzing students' learning preferences and performance. It provides customised tutorials, explanations, and problem sets. This personalized process

attracts students for engagement and reduces the achievement gaps, which is required for the NBA's Graduate Attributes framework.

Furthermore, generative tools help in creating case studies, hypothetical situations, and design challenges, which encourage students to create creativity and critical thinking that support higher-order thinking skills as per Bloom's revised taxonomy [18]. Instead of passive consumption, this approach promotes active learning and knowledge creation by students.

In addition, AI - based feedback tools give students a formative feedback system in real time that enhances the quality of their learning and the responsiveness of the faculty. It focuses on continuous internal quality assurance and learner satisfaction based on NAAC.

5.2 | Administrative and Academic Efficiency

GenAI automated the routine tasks like course file preparation, creation of CO-PO mapping matrices, question paper blueprints, and report writing, which overwhelmed the faculty member because it reduced the document preparation workload, as stated by Phung et al. [11]. This reduces administrative time while improving consistency and traceability.

As per Ifenthaler et al. [19], AI- powered integrated systems support attendance tracking, project evaluation, and rubric-based assessment, which contributes to the improvement of institutional efficiency and transparency during the period of any NBA and NAAC audits or accreditations.

5.3 | Quality Assurance and Accreditation

AI-driven analytics systems collect and analyze data that is related to learning outcomes, student performance, and feedback trends, and display the results in a graphical dashboard manner. These dashboards then help the IQAC in preparing their Self-Study Reports (SSR) for NAAC and SARs, which are required for the NBA accreditation.

As per the AICTE–NBA–NAAC framework, it works on emphasizing evidence-based continuous improvement. AI-powered visual analytics in the form of attainment of CO-PO as spider charts or trend graphs for graduate employability support informed decision-making and manifest institutional accountability [3], [4].

6 | Challenges and Ethical Considerations

While AI's generative capabilities hold a huge amount of potential, in having those integrated into OBE systems presents several challenges that should be reviewed.

6.1 | Academic Integrity and Plagiarism

GenAI can inadvertently enable academic dishonesty by producing essays or code solutions that appear original. Such policies should be supported by institutions through the implementation of AI plagiarism detection systems. Moreover, the faculty should highlight responsible AI use, viewing GenAI as a tool for enhancement rather than a substitute for learning.

6.2 | Data Privacy and Security

AI-powered systems amass and process bulk volumes of data on students. This inevitably poses serious questions about data privacy, ownership, and consent, as noted by Nguyen [14]. Engineering colleges in India, therefore, need to implement the DPDP Act 2023 [20] and shall deploy secure AI platforms that are in line with institutional data governance frameworks.

6.3 | Faculty Readiness and Digital Divide

AI integration will be effective, given faculty competence and willingness to adapt. Most educators lack technical familiarity with AI tools or even fear that automation will undermine the pedagogical role of teachers. Regular capacity-building workshops and training in AI literacy will help address these concerns.

Moreover, institutional infrastructure disparities in the form of low-bandwidth environments or limited computing resources found in rural engineering colleges will limit the adoption of AI.

6.4 | Ethical Artificial Intelligence Usage

Ethical use of AI dwells on three foundational elements: transparency, accountability, and fairness. Bias in AI-generated data or recommendations may affect grading or evaluation. The institutionalization of ethics review committees and the introduction of AI governance policies will contribute to ensuring responsible AI principles are followed.

7 | Integration within National Board of Accreditation, National Assessment and Accreditation Council, and AICTE Frameworks

OBE, quality assurance, and continuous improvement are essential to India's accreditation and regulatory frameworks, including AICTE, NBA, and NAAC. GenAI can directly contribute to improving adherence to the rules set up by each agency.

7.1 | All India Council for Technology and Educatio's Role: Policy and Curriculum

The AICTE model curriculum emphasizes outcome-based pedagogy, faculty training, and innovation [3]. GenAI tools can assist institutions in aligning courses with the AICTE-prescribed structure.

For instance, AI can generate sample Program Educational Objectives (PEOs) and Program Outcomes (POs) for emerging areas such as AI and Data Science, reducing ambiguity and ensuring policy compliance.

7.2 | National Board of Accreditation Accreditation: Attainment and Continuous Improvement

For the NBA's accreditation process, the evidence requires such as CO, PO, and PSO attainment with quantitative and qualitative analysis [1]. AI- based tools can automate CO–PO correlation matrices, calculate attainment levels, and produce graphical summaries of student performance trends (*Table 2*).

Table 2. Integrating AI tools with NBA/NAAC guidelines.

Framework	Criterion/Parameter	AI Application	Outcome
AICTE	Curriculum design and model syllabus	AI-generated course outcomes and mapping templates	Curriculum alignment and standardization
NBA	Continuous improvement (criterion 5)	Automated attainment data analysis and trend visualization	Evidence-based reporting
NAAC	Teaching-learning and evaluation (criterion 2)	AI-driven content generation and feedback analytics	Improved quality and student satisfaction
NAAC	Institutional values and best practices	AI-assisted documentation and best-practice reports	Enhanced transparency and accountability

7.3 | National Assessment and Accreditation Council Accreditation: Documentation and Quality Assurance

The NAAC emphasizes qualitative institutional performance through the help of seven criteria such as curricular aspects, teaching-learning & evaluation, research, innovation, infrastructure, student support &

progress, leadership & management, and institutional values [4]. One of the key benefits of GenAI is that it can support preparation for the SSR, Annual Quality Assurance Reports (AQAR), and best practice documentation through the analysis of institutional data and generating evidence-based narratives.

Moreover, the analytics generated by AI can illustrate a student- centric approach and innovation, which are major indicators for the NAAC accreditation framework.

8 | Case Study Example: Implementation at a Hypothetical Engineering College

For example, consider an educational institution that implements GenAI-integrated OBE according to the AICTE, NBA, and NAAC framework.

I. Curriculum formation: the institution implements AI tools to create assessment rubrics based on Bloom's taxonomy and CO-PO mapping for each course, as per the alignment.

II. Teaching learning process: the "AI-infused" learning platforms provide personalized quizzes, adaptive content for learning, and multilingual clarifications as per the students' requirements.

III. Evaluation: the machine learning-assisted grading system is a great help in the assessment of the design projects and assignments, which improves the accuracy and reduces the faculty workload.

IV. Accreditation: the IQAC is employing AI analytics in the generation of the NAAC and NBA reports, thus guaranteeing traceability and evidence-based evaluation of the college.

Consequently, the institution notes an increase in student participation, a decrease in faculty workload, and a rise in the level of attainment of POs.

9 | Future Prospects

The generative AI's role in OBE-focused engineering education will move towards a stronger connection, more personalization, and better analytics.

9.1 | Artificial Intelligence-Driven Predictive Analytics

The AI is capable of foreseeing how a student will do under certain conditions based on the previous performance, attendance, and grading patterns [9]. The at-risk students can then be helped right away, which, in turn, leads to better overall POs.

9.2 | Artificial Intelligence-Powered Accreditation Dashboards

Tailor-made dashboards are able to automatically gather, process, and illustrate the OBE data that is to be submitted to AICTE, NBA, and NAAC. Connecting with the National Academic Depository (NAD) and the Learning Management Systems (LMS) can make institutional workflows much easier.

9.3 | Generative Artificial Intelligence in Research and Innovation

AI may aid the faculty and students in carrying out literature reviews, paper summarization, and the drafting of technical reports [4]. These AI tools cultivate the research culture and are a source of innovation, which is the requirement prescribed by the NBA under criterion 3.

9.4 | Policy and Ethical Artificial Intelligence Governance

National government policies should facilitate the ethical integration of AI in the education sector to emphasize transparency, inclusiveness, and data privacy. The AICTE and University Grants Commission (UGC) might cooperate in formulating AI Literacy Frameworks to equip educators through training and to promote the responsible use of AI.

10 | Conclusion

The GenAI is an effective tool for transforming India's engineering outcome-based education system. Its application covers the entire OBE cycle: design, delivery, assessment, feedback, and documentation while getting aligned with AICTE's regulatory guidelines, NBA's accreditation standards, and NAAC's quality assurance benchmarks.

Despite that, effective implementation calls for the readiness of the faculty, the presence of ethical frameworks, and a sturdy digital infrastructure. The engineering colleges must look at the AI adoption in the context of a strategic quality enhancement initiative rather than a technological trend.

The combined forces of GenAI and OBE can place Indian engineering education in a global manner; it would be student- centred, innovation-driven, and thus, the vision of Viksit Bharat through academic excellence and technological empowerment will be realized.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Data Availability

All data generated or analyzed during this study are included in this published article. No additional data are available.

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