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Transforming Teaching and Learning in Higher Education with Generative AI: A Narrative Literature Review Based on the SAMR Framework

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Abstract. *This study aims to examine the integration of Generative AI in higher education through the perspective of the SAMR framework, which consists of Substitution, Augmentation, Modification, and Redefinition. The study used a narrative literature review method by analyzing 30 relevant academic publications published between 2023 and 2025. The findings reveal that the implementation of GenAI in higher education is still predominantly situated at the substitution and augmentation levels, with primary functions focused on improving efficiency, automation, and academic assistance. In contrast, transformative applications categorized under modification and redefinition remain relatively limited and are still in the early stages of development. This study concludes that although Generative AI possesses substantial potential to transform higher education practices, its current implementation has not yet reached an optimal transformative stage. Therefore, future educational practices should emphasize the development of more transformative implementation strategies that move beyond efficiency-oriented utilization toward fostering pedagogical innovation and meaningful learning transformation.*

Keywords: *Generative Artificial Intelligence; SAMR Framework; Higher Education; Pedagogical Transformation; ChatGPT; Educational Technology.*

1. INTRODUCTION

The rapid advancement of Generative Artificial Intelligence (GenAI) technologies has enabled new possibilities for teaching and learning in higher education. Large Language Models (LLMs) such as ChatGPT, Google Gemini, Microsoft Copilot, and Anthropic's Claude have demonstrated significant capabilities in generating human-like text, creating educational content, providing personalized feedback, and supporting various pedagogical activities (Baidoo-Anu & Ansah, 2023; Kasneci et al., 2023; Lim et al., 2023). These AI-powered tools are capable in giving sophisticated assistance in instructional design, assessment creation, academic writing support, and collaborative learning facilitation (Dai et al., 2023; Dempere et al., 2023).

The widespread availability of GenAI tools has created various opportunities for both educators and students. Faculty members are exploring how these technologies can enhance course design, automate routine tasks, and provide more personalized learning pathways (Prather et al., 2023). Students are leveraging GenAI for research assistance, writing support, concept explanation, and study optimization (Cotton et al., 2024; Farrokhnia et al., 2024). The majority of university students in various countries have

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used GenAI tools for academic purposes, with ChatGPT being the most widely adopted platform (Tlili et al., 2023).

However, the adoption of GenAI tools does not necessarily translate into meaningful pedagogical transformation. A critical distinction must be drawn between the use of technology for efficiency and its use for genuine educational innovation that creates fundamentally new learning experiences (Zawacki-Richter et al., 2019). This distinction is precisely what the SAMR (Substitution, Augmentation, Modification, Redefinition) framework, developed by Puentedura, seeks to capture (Puentedura, 2013). The SAMR model provides a framework than can be used by educators to evaluate the depth and transformative potential of technology integration in educational settings (Puentedura, 2015).

Despite the rapid increase of research on GenAI in education, a thorough examination of how these tools map onto the SAMR framework specifically within higher education contexts remains limited. Most existing studies focus on isolated use cases, specific disciplines, or particular tools, without providing a comprehensive framework for understanding the transformative potential of GenAI across the full spectrum of pedagogical applications (Extance, 2023; Warschauer et al., 2023).

This study addresses these gaps by conducting a narrative literature review that examines how GenAI tools are being integrated into higher education using the SAMR framework. Specifically, this study aims to: (1) map current GenAI applications in higher education to the four levels of the SAMR framework; (2) identify the predominant patterns of GenAI use across substitution, augmentation, modification, and redefinition levels; and (3) propose directions for more transformative AI-enhanced pedagogical practices. The findings of this review are intended to inform educators and institutions in the higher education sector about the current state and future potential of GenAI in transforming higher education.

2. LITERATURE REVIEW

Generative AI in Higher Education

Generative Artificial Intelligence refers to a class of machine learning models capable of generating new content based on patterns learned from large training datasets (Baidoo-Anu & Ansah, 2023). Unlike earlier AI systems designed for task-specific

functions, GenAI models are capable of engaging in open-ended dialogue, reasoning across domains, and producing outputs that closely resemble human-generated content (Herget & Da Silva Ferreira, 2025; Kasneci et al., 2023). The accessibility of these models through user-friendly interfaces has accelerated their adoption across various sectors, with education being among the most significantly impacted.

In higher education specifically, GenAI tools have been applied in various activities. Instructors have used these tools to make course syllabi, design rubrics, create assessment items, produce lecture summaries, and develop differentiated learning materials (Miroshnikov & Bennet, 2025). Students have used GenAI for drafting essays, generating research outlines, summarizing complex readings, solving problem sets, and receiving instant feedback on their work (Cotton et al., 2024; Farrokhnia et al., 2024). Additionally, institutions have begun integrating GenAI into learning management systems to enable adaptive learning and intelligent tutoring capabilities (Alier et al., 2025).

The rapid adoption of GenAI in academia has created controversy. Concerns about academic dishonesty, over-reliance on AI-generated content, and the erosion of critical thinking skills have prompted universities worldwide to develop policies governing the use of these tools (Perkins, 2023). At the same time, educators who embrace GenAI argue that its integration can enhance learning outcomes, open access to high-quality educational support, and prepare students for an AI-augmented workforce (Cordero et al., 2025). The tension between these perspectives underscores the need to evaluate GenAI's role in higher education using the SAMR model.

The SAMR Framework

The SAMR model, developed by Ruben Puentedura, provides a hierarchical framework for categorizing the degree to which technology transforms educational tasks and learning experiences (Puentedura, 2013). The model consists of four progressive levels, divided into two broad categories: Enhancement (Substitution and Augmentation) and Transformation (Modification and Redefinition). Each level represents an increasing degree of pedagogical change enabled by technology integration.

At the substitution level, technology performs as a direct replacement for a traditional tool or method, with no functional change in the task itself. For example, a

student typing an essay in a word processor instead of writing it by hand represents substitution. While substitution may improve convenience or efficiency, it does not alter the fundamental nature of the learning activity or its outcomes (Puentedura, 2015; Zhuang, 2025).

Augmentation occurs when technology replaces a traditional tool and also provides some functional improvement that enhances the task. An example would be using a word processor with spell-check and grammar suggestions, which improves the writing process beyond simple substitution. At this level, technology adds value to existing tasks but does not fundamentally redesign them (Puentedura, 2015; Wang et al., 2024).

Modification represents the first level of genuine transformation, where technology enables significant task redesign that would be difficult or impossible without it. For instance, students collaborating in real-time on a shared document with embedded multimedia, interactive annotations, and peer feedback represents a modified learning experience that transcends traditional paper-based tasks (Puentedura, 2015).

Redefinition is the highest level of the SAMR model, where technology enables the creation of entirely new tasks or learning experiences that were previously unthinkable. Examples include students co-creating interactive simulations, engaging in global collaborative projects with AI-mediated translation, or designing AI-powered learning tools as part of their coursework. Redefinition represents a paradigm shift in educational possibilities (Puentedura, 2015).

Intersection of GenAI and SAMR in Higher Education

The intersection of GenAI capabilities and the SAMR framework creates an analytical structure for evaluating the transformative potential of AI tools in education. While earlier applications of the SAMR model focused on tools such as word processors, presentation software, and learning management systems, the emergence of GenAI introduces qualitatively different possibilities at each level of the framework (Shamir-Inbal et al., 2024). GenAI's ability to generate, analyze, and respond to complex inputs means that its applications span the full SAMR spectrum, from simple substitution of manual tasks to the redefinition of learning itself.

Scholars have begun applying SAMR-like frameworks to evaluate AI integration in education (Cordero et al., 2025; Khawaja & Kadi, 2025). Similarly, Yunjo et al. found

that generative AI integration in educational settings predominantly reflects enhancement rather than transformation (Cordero et al., 2025). These findings suggest a gap between the transformative potential of GenAI and its actual pedagogical implementation, which this study seeks to analyze and evaluate further within the higher education landscape.

3. RESEARCH METHOD

This study employs a narrative literature review methodology to examine the integration of Generative AI in higher education through the SAMR framework. A narrative literature review is a qualitative synthesis approach that aims to summarize and critically analyze existing research on a given topic, identify patterns and themes across studies, and provide an interpretive overview of the state of knowledge in a field (Baumeister & Leary, 1997; Green et al., 2006). Unlike systematic reviews that follow strict inclusion protocols and quantitative synthesis methods, narrative reviews allow for broader thematic exploration and interpretive flexibility, making them well-suited for emerging and rapidly evolving fields such as AI in education (Cronin et al., 2008).

The literature search was conducted by using Google Scholar. The search period was restricted to publications from January 2023 to December 2025 to reflect the most recent and relevant research on GenAI in higher education.

The following search terms and their combinations were used: "generative AI", "ChatGPT", "large language models", "higher education", "university", "college", "SAMR framework", "artificial intelligence", "educational technology", "AI integration", "pedagogy", "teaching and learning".

Inclusion criteria for this review were: (1) journal articles, conference papers, or scholarly book chapters published between 2023 and 2025; (2) studies focusing on GenAI tools; (3) studies relevant to higher education contexts; and (4) studies addressing pedagogical, or instructional dimensions of GenAI use. Exclusion criteria included: (1) purely technical papers on AI model development without educational applications; (2) non-English language publications.

After applying inclusion and exclusion criteria and assessing relevance to the SAMR framework, 30 relevant publications were selected for analysis. These papers were

analyzed, with each study categorized according to the SAMR level most closely aligned with the GenAI application described.

4. RESULTS AND DISCUSSION

The analysis of 30 selected publications shows a clear pattern in the distribution of GenAI applications across the four SAMR levels. The majority of identified applications fall within the substitution and augmentation levels, reflecting a predominant focus on efficiency, convenience, and incremental enhancement of existing educational tasks. This confirms that GenAI adoption in higher education is primarily characterized by enhancement rather than transformation, consistent with broader patterns of educational technology adoption (Zawacki-Richter et al., 2019).

Substitution: GenAI Replacing Traditional Tools

At the substitution level, GenAI tools are used as direct replacements for traditional tools or methods. This is the most prevalent pattern of GenAI use identified in the reviewed literature, reflecting the fast adoption and immediate utilization of these tools for both students and educators (Cotton et al., 2024; Farrokhnia et al., 2024).

The most common substitution use case involves students using ChatGPT or similar tools to draft essays, reports, or other written assignments that they would previously have written manually. Students primarily use LLMs for initial draft generation, effectively substituting the blank-page writing process with AI-mediated content generation (Mennella & Quadros-Mennella, 2024; Wang et al., 2024).

For educators, substitution-level GenAI use typically involves using AI tools to generate quiz questions, create rubrics, or draft course materials that would previously have been created manually (de Winter et al., 2023).

While substitution-level use offers real benefits in terms of time savings and accessibility, it also raises concerns about the depth of learning and skill development. When students substitute AI-generated content for their own cognitive effort, there is a risk that essential skills such as critical thinking and argumentation skills may be underdeveloped (Perkins, 2023). This concern is particularly acute in disciplines where writing is considered a core competency and a method for learning rather than merely a product (Rudolph et al., 2023).

Augmentation: GenAI Enhancing Tasks with Functional Improvement

Augmentation represents the second most prevalent pattern of GenAI use in higher education, characterized by technology-enhanced tasks that provide functional improvements over traditional methods. At this level, GenAI tools add value to existing educational activities by providing capabilities that were not previously available or easily accessible (Puentedura, 2015).

Personalized feedback represents one of the most significant augmentation-level applications of GenAI in higher education. Unlike traditional feedback, which is constrained by instructor time and availability, AI-powered feedback systems can provide immediate, detailed, and personalized responses to student work at scale (Alier et al., 2025; Dai et al., 2023).

Intelligent tutoring systems powered by GenAI represent another important augmentation application. These systems can engage students in Socratic dialogue, adapt explanations to individual learning levels, and provide scaffolded support for complex problem-solving tasks (Khawaja & Kadi, 2025). Khawaja et al. documented a strategy for deploying GenAI as an intelligent tutoring system in higher education, finding that students who used the AI tutor demonstrated improved conceptual understanding compared to those relying solely on traditional resources (Khawaja & Kadi, 2025).

Adaptive assessment represents a third key augmentation application. GenAI tools can generate personalized quiz questions calibrated to individual student performance levels, provide targeted remediation, and track learning progress over time (Prather et al., 2023). GenAI can be used to augment curriculum reform in higher education study programs, enabling more adaptive and responsive assessment practices (Herget & Da Silva Ferreira, 2025; Oyebola Olusola Ayeni et al., 2024; Zhuang, 2025).

Modification: GenAI Enabling Significant Task Redesign

Modification-level applications of GenAI in higher education involve significant redesign of educational tasks in ways that leverage the unique capabilities of AI to create new learning experiences. While less prevalent than substitution and augmentation uses, modification-level applications represent an important step toward transformative AI integration (Shamir-Inbal et al., 2024; Zawacki-Richter et al., 2019).

AI-assisted collaborative learning projects represent a modification-level application. In these contexts, GenAI tools serve not merely as writing or research assistants but as active participants in collaborative knowledge construction. Shamir-Inbal et al. documented how AI integration promoted significant changes in teaching and learning processes, enabling students to engage in collaborative tasks with AI as a co-creator rather than a simple tool (Kovari, 2025; Shamir-Inbal et al., 2024). Students in these modified learning environments demonstrated higher levels of critical engagement with AI-generated content, learning to evaluate, refine, and build upon AI outputs rather than simply accepting them (Singhachotsukpat et al., 2025).

Flipped classroom models enhanced by GenAI represent another modification-level application. In AI-augmented flipped classrooms, GenAI tools generate personalized pre-class learning materials, adaptive video summaries, and customized problem sets tailored to individual student needs, fundamentally redesigning the pre-class learning experience (Alier et al., 2025; Ray & Sikdar, 2024).

Real-time simulation and scenario-based learning represent a third modification-level application. GenAI tools can generate dynamic scenarios that adapt to student decisions in real time, creating immersive case-based learning experiences in fields such as medicine, law, business, and engineering (Dempere et al., 2023; Extance, 2023). These AI-powered simulations represent a significant redesign of traditional case study methods, enabling more dynamic and personalized scenario-based learning that was previously achievable only through expensive human-facilitated role-play exercises (Alfredo et al., 2025; Warschauer et al., 2023).

Redefinition: GenAI Enabling Previously Inconceivable Learning Tasks

Redefinition represents the highest and most transformative level of the SAMR framework, where technology enables entirely new forms of learning that were previously unthinkable. While redefinition-level applications of GenAI in higher education are currently the least common, they represent the most potentially impactful frontier of AI-enhanced pedagogy (Puentedura, 2015; Shamir-Inbal et al., 2024).

The co-creation of AI-powered learning environments by students represents a redefinition-level application. In these contexts, students do not merely use AI tools but actively design, build, and deploy them as part of their learning. Miroshnikov & Bennett

documented how generative AI literacy programs enabled students to move beyond passive consumption to active creation of AI-powered educational tools, fundamentally redefining the student role from knowledge consumer to knowledge creator (Miroshnikov & Bennet, 2025). This shift represents a transformation of the educational experience, with students developing not only domain knowledge but also AI design and critical evaluation competencies (Lee et al., 2023).

Interdisciplinary AI-mediated research projects represent another redefinition-level application. GenAI tools can facilitate interdisciplinary collaboration by serving as translators between disciplinary languages, synthesizers of cross-domain knowledge, and generators of novel research hypotheses (Lim et al., 2023; Tlili et al., 2023). These capabilities enable students and researchers to engage in forms of interdisciplinary inquiry that were previously constrained by disciplinary boundaries and the limits of individual human expertise (Xu et al., 2024).

Immersive AI-generated learning environments represent a third redefinition application, particularly when combined with extended reality (XR) technologies, such as Virtual Reality (VR) and Augmented Reality (AR). GenAI can dynamically generate dynamic virtual environments, characters, and scenarios that adapt to learner behavior, creating personalized immersive learning experiences at a level of customization previously impossible (Dempere et al., 2023; Warschauer et al., 2023). While still largely experimental, these applications point toward a future of higher education in which the boundaries between formal instruction, experiential learning, and real-world practice are fundamentally blurred.

5. CONCLUSION

This study explored how Generative AI is being used in higher education by using the SAMR framework and reviewing 30 academic publications from 2023 to 2025. The results show a clear pattern: most uses of GenAI in higher education are still at the substitution and augmentation levels. This means GenAI is mainly being used to improve efficiency, make tasks easier, and slightly improve current teaching and learning practices. More advanced and transformative uses at the modification and redefinition levels are still rarely found in current practice.

This pattern shows that higher education institutions are still beginning to understand and use the full potential of GenAI. Most current uses only improve existing

practices rather than create major changes. This is because the technology is still new, and there are also structural, cultural, and institutional challenges that limit further adoption. Faculty members who do not have enough AI knowledge or training support, universities without clear AI policies, and students who have not developed important AI skills are less likely to use GenAI in more advanced and transformative ways.

This study recommends that faculty members design learning experiences that use GenAI at the modification and redefinition levels by moving beyond simple task automation toward transformative learning activities. In practice, this involves redesigning assessments, curricula, and teaching approaches to emphasize critical thinking, collaboration, creativity, and AI literacy. At the modification level, students can act as co-knowledge creators by using GenAI to collaboratively revise lesson plans, analyze case studies, or improve research drafts through iterative feedback and reflection. At the redefinition level, students may co-create entirely new learning products that were previously difficult to achieve, such as AI-assisted simulations, multilingual educational resources, interactive tutoring tools, or community-based digital projects, while instructors guide them in evaluating the accuracy, ethics, and relevance of AI-generated content.

For higher education institutions, this study recommends the integrated development of AI governance frameworks and faculty professional development programs to enable GenAI's transformative capabilities in teaching and learning. In practice, this includes training faculty members to redesign assessments, create collaborative and inquiry-based learning experiences, and integrate GenAI into teaching, research, and knowledge creation activities. Institutions can also support innovation by encouraging interdisciplinary projects, AI-assisted learning environments, and new pedagogical models that position students as active co-creators of knowledge. Institutions that proactively align governance, infrastructure, and continuous faculty development will be more able to utilize the transformative potential of GenAI in higher education.

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