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Roles of Generative Artificial Intelligence in Enhancing Educational Sustainability in Higher Education (An Exploratory Study of Experts' Perspectives)

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ABSTRACT

Amid rapid epistemic and technological transformations, educational sustainability has emerged as a key orientation that higher education institutions seek to strengthen, particularly with the advent of generative artificial intelligence and the potential it offers for transforming the educational system. Accordingly, the present study aimed to explore the roles of generative artificial intelligence in enhancing educational sustainability in higher education institutions from the perspective of experts. The study adopted a qualitative phenomenological approach, and semi-structured interviews were used to collect data from twelve experts, selected through criterion-based purposive sampling. The data were analyzed using thematic analysis to identify semantic patterns and shared meanings across the experts' perspectives. Six roles emerged: continuity, quality, accessibility, renewal, flexibility, and lifelong learning. These roles reflect the multiple potentials of generative artificial intelligence in sustaining educational processes, continuously improving the quality of educational practices, expanding access to learning experiences, renewing teaching resources and practices, enhancing the educational system's capacity to adapt to change, and supporting individuals' ongoing cognitive and professional growth. The study recommends adopting institutional strategies for employing generative artificial intelligence to enhance educational sustainability, integrating its applications into university learning environments, and developing the competencies required to use it effectively and sustainably.

Keywords: generative artificial intelligence, educational sustainability, higher education, phenomenological approach, thematic analysis.

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Introduction

Higher education sustainability has become a strategic orientation attracting growing attention amid the rapid epistemic, technological, social, and economic transformations the world is undergoing, and the challenges these transformations pose to higher education institutions' capacity to fulfill their present and future roles. The success of universities is no longer contingent solely on achieving their current educational objectives. It is now also tied to their ability to sustain their instructional, research, and institutional practices, respond to society's changing needs, and contribute to building a more sustainable future (Munaro & John, 2025; Hinterleitner et al., 2026). In this context, higher education sustainability extends beyond environmental concerns and the rationalization of resource consumption. It encompasses an integrated institutional orientation spanning instructional, research, and administrative practices, aimed at balancing present needs with future requirements so as to ensure the continuity of universities and the effectiveness of their roles (Ankareddy et al., 2025). Achieving such sustainability is likewise linked to universities' ability to build an institutional culture that supports sustainability, such that sustainability becomes an integral part of the institution's values, orientations, and practices rather than a mere set of discrete initiatives and activities (Holst et al., 2025).

The educational dimension is one of the pivotal dimensions of higher education sustainability. It relates to universities' capacity for the continuous development of curricula and teaching practices, the use of innovative instructional strategies, and the integration of educational leadership, curriculum design, and teaching and learning processes (Ncube et al., 2026). It also involves developing learning pathways that respond to learners' changing needs and preserve the quality and relevance of educational experiences (Boman et al., 2025). Higher education sustainability is further associated with promoting equity and inclusion in education, through policies and practices that ensure learners from all backgrounds can access educational opportunities and resources and that reduce the barriers to their effective participation in learning experiences (Filippou et al., 2025; Maurya et al., 2025). Its requirements also extend to strengthening universities' resilience and adaptability in the face of crises and disruptions that may affect the performance of their educational roles, and to building educational systems characterized by flexibility and the ability to continue under changing conditions (Coelho & da Silva, 2026; Leal Filho et al., 2026). From this standpoint, educational sustainability, as a principal dimension of higher education sustainability, can be understood as an orientation aimed at ensuring the continued delivery of high-quality education, the continuous renewal of educational resources and practices, the enhancement of access to learning opportunities, responsiveness to learners' changing needs, and the development of the educational system's capacity to adapt to present and future challenges. This calls for a sustained search for innovative approaches and technologies that can strengthen universities' capacities to achieve educational sustainability, moving beyond the mere continuity of

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educational services toward sustaining their quality and effectiveness and their capacity for renewal and adaptation.

In light of the drive to enhance higher education sustainability, artificial intelligence (AI), and particularly generative artificial intelligence (GenAI), has emerged as a technology with broad potential to bring about qualitative transformations in the educational system. It can do so by reshaping teaching practices, developing learner support systems, and strengthening universities' capacity to respond to evolving educational needs (Belkina et al., 2025). The potential offered by GenAI goes beyond improving the efficiency of certain traditional educational processes to the possibility of building more flexible, adaptive, and sustainable learning environments by personalizing learning experiences, providing continuous instructional support, and developing the skills needed to navigate future transformations (Tilwani et al., 2026). In this regard, GenAI can contribute to sustaining the quality of higher education by enhancing learning outcomes. A meta-analysis conducted by Chen and Cheung (2025), which included 57 studies, found a positive effect of GenAI on university students' learning outcomes, particularly in relation to academic achievement, language skills, higher-order thinking, and motivational and affective aspects, although the magnitude of this effect varied across educational contexts. AI can likewise play a role in strengthening the continuity of instructional support through intelligent tutoring systems that allow learners to obtain guidance and assistance according to their individual needs, a role supported by the findings of some experimental studies that indicated the effectiveness of these systems in enhancing learning outcomes and increasing learning efficiency (Kestin et al., 2025).

The potential of GenAI also extends to the continuous development and renewal of educational resources, to supporting faculty members in designing instructional content and activities, and to reconsidering teaching and assessment approaches in line with epistemic and technological change (Belkina et al., 2025). It can further contribute to sustaining assessment and feedback processes by providing immediate, personalized feedback that matches learners' levels and needs and supports their cognitive and affective development, while stressing the importance of integrating AI-generated feedback with that provided by faculty members (Öztürk & Çebi, 2026). From a perspective directly related to educational sustainability, the findings of Jallali et al. (2026), based on data from 387 university students, indicated a positive relationship between the use of AI-supported learning tools and educational sustainability, with learning engagement and digital resilience playing an important role in strengthening this relationship.

Nevertheless, employing AI to enhance educational sustainability does not depend solely on the technical capabilities of its applications. It also depends on universities' ability to develop the human competencies required for the informed and responsible use of these applications, and to equip learners and faculty members with the skills to engage with them critically (Williams, 2026). It further depends on their ability to address challenges related to equity of access to these technologies, cognitive over-reliance on them, academic integrity, data privacy, and the validity of the AI-supported instructional and assessment practices (Komodromos, 2026), in addition to

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accounting for the environmental impacts of their use and the associated consumption of energy and resources (Radovan et al., 2026). Despite growing research interest in the potential of GenAI in higher education, a substantial portion of the studies still focuses on its applications for performing educational tasks and on short-term learning outcomes, while comparatively little attention has been paid to issues such as self-regulated learning, educational equity, and the long-term effects of these applications (Lin et al., 2026). Hence the need to explore the roles of AI from a more comprehensive perspective, one concerned with its capacity to enhance educational sustainability in higher education institutions, going beyond the improvement of immediate educational outcomes to sustaining their quality, effectiveness, accessibility, and capacity for renewal and adaptation to future change.

Statement of the Problem

Despite growing interest in employing generative artificial intelligence (GenAI) in higher education, and despite the potential that numerous studies have demonstrated for improving educational practices and learning outcomes, moving from using this technology to achieve immediate instructional gains to employing it strategically to enhance educational sustainability remains a research challenge that warrants further investigation. Many studies have pointed to the effectiveness of GenAI in improving academic achievement, developing learners' skills, and enhancing the efficiency of teaching practices (Belkina et al., 2025; Chen & Cheung, 2025). However, realizing these educational benefits does not necessarily mean that they can be maintained over the long term or generalized across different educational contexts. In this regard, the scoping review conducted by Lin et al. (2026), which covered 394 empirical studies, revealed that research attention has concentrated on using GenAI to support existing educational tasks, particularly writing, feedback, and instructional guidance, while comparatively little attention has been paid to issues related to self-regulated learning and educational equity. It also revealed that a substantial share of these studies relied on research methods designed to measure short-term outcomes. Similarly, the systematic review by Liang et al. (2026) highlighted the importance of understanding the nature of human–AI interaction when GenAI is employed in educational settings, moving beyond a focus on the technical capabilities of these applications to examine how they can be used to achieve educational goals of lasting value.

Moreover, despite increasing scholarly interest in the relationship between AI and sustainability in higher education, a portion of the literature has addressed this relationship in terms of AI's contributions to achieving the sustainable development goals, or to enhancing universities' institutional, environmental, and economic sustainability, without focusing independently on how educational processes and practices themselves can be sustained (Toha, 2026; Low et al., 2026). The scoping review by Daniel et al. (2026) likewise revealed a scarcity of studies addressing the long-term effects of employing AI to achieve sustainability in higher education institutions, as part of the existing literature rests on theoretical conceptualizations or limited-scale applications. This reflects the need for further studies that address the institutional and applied dimensions of AI-supported sustainability. In a context closer

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to educational sustainability, Jallali et al. (2026) examined the relationship between the use of AI-supported learning tools and educational sustainability by investigating the mediating role of learning engagement and the moderating role of digital resilience. Nevertheless, that study focused on testing relationships among a specific set of variables from the students' perspective, leaving room to explore the multiple, complementary roles that AI can play in enhancing educational sustainability at the level of the university educational system.

The research problem also emerges in light of the challenges accompanying the use of GenAI in higher education, which may limit its capacity to contribute to educational sustainability. Some studies have revealed a gap between institutional investment in AI applications and the realization of actual transformations in educational practices, alongside disparities in access to these applications and differing levels of acceptance among students and faculty members (Altamirano et al., 2026). Studies have also pointed to challenges in developing institutional policies that govern the use of AI and to the adequacy of such policies in addressing the diverse needs of disciplines and instructional practices (McDonald et al., 2025; Kushnir & Mbah, 2026). Further challenges relate to academic integrity, the reliability of outputs, and over-reliance on GenAI applications, with potential negative consequences for learner autonomy and the validity of assessment processes (Hendal & Chowdhury, 2026; Wang & Cai, 2026). In this connection, Komodromos (2026) emphasized that achieving GenAI-supported pedagogical sustainability requires balancing educational innovation with ethical responsibility and educational equity, so as to preserve the quality and values of educational practices over the long term.

Given the multidimensional nature of educational sustainability and the instructional and institutional practices and orientations associated with it, understanding the roles of GenAI requires moving beyond the study of individual usage experiences to drawing on the integrated insights of those with expertise in higher education and educational technology. This is consistent with research orientations that stress the importance of involving experts and stakeholders in developing educational conceptualizations and models that respond to technological change and integrate technical innovation with pedagogical and ethical requirements (Zagami, 2026).

Accordingly, the problem of the present study lies in the limited integrated understanding of the roles that GenAI can play in enhancing educational sustainability within higher education institutions. The evidence is scattered across studies of immediate educational benefits, studies of AI applications for achieving sustainability in its broader sense, and studies of isolated educational variables. This prompted the researcher, through the present study, to explore experts' perspectives on these roles, to identify the challenges that may constrain them and the requirements for activating them, and ultimately to arrive at a conceptual framework that helps guide higher education institutions in employing GenAI to enhance educational sustainability.

Research Question

In light of the research problem outlined above, the study seeks to answer the following main question:

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How can generative artificial intelligence contribute to enhancing educational sustainability in higher education institutions from the perspective of experts?

Research Objective

The present study aims to explore the roles that generative artificial intelligence can play in enhancing educational sustainability in higher education institutions from the perspective of experts, with a view to developing a conceptual framework that clarifies the nature of these roles and how they can be activated.

Significance of the Study

1. Enriching the research literature on the use of generative artificial intelligence to enhance educational sustainability in higher education institutions.
2. Directing researchers' attention toward examining the sustained effects of generative artificial intelligence, beyond a focus on its immediate educational impacts.
3. Supporting university leaders and decision-makers in developing policies and strategies related to educational sustainability supported by generative artificial intelligence.
4. Helping higher education institutions set investment priorities for generative artificial intelligence applications that support educational sustainability.
5. Guiding efforts to develop educational practices in ways that strengthen the continuity, quality, flexibility, and adaptability of education to future change.

Delimitations of the Study

1. Subject delimitations: Exploring the roles of generative artificial intelligence in enhancing educational sustainability in higher education institutions, without directly addressing the economic and environmental dimensions of university sustainability.
2. Human delimitations: A group of experts and specialists in educational technology, artificial intelligence, and the development of university education.
3. Temporal delimitations: The second semester of the 2025/2026 academic year.
4. Spatial delimitations: Higher education institutions in the Kingdom of Saudi Arabia.

Study Terminology

1. Generative Artificial Intelligence

Feuerriegel et al. (2024) defined it as a set of computational technologies capable of generating seemingly new and meaningful content, such as text, images, and audio, based on the data on which they were trained.

In the present study, the researcher operationally defines it as "a set of intelligent applications and systems capable of generating educational content and resources, interacting with users, and providing responses tailored to their needs, whose potential roles in enhancing educational sustainability in higher education institutions are explored in this study from the perspective of experts."

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2. Educational Sustainability

In the context of the sustainability of educational innovations, Tappel et al. (2023) defined sustainability as the process of integrating the core components of innovations into institutional practices and expanding their scope of application so that they can continue and adapt to evolving work requirements.

In the present study, the researcher operationally defines it as "the capacity of the educational system in higher education institutions to ensure the continued delivery of high-quality education, the continuous development of its educational practices and resources, the enhancement of access to learning opportunities, and adaptation to learners' needs and to present and future changes, whose potential enhancement through the use of generative artificial intelligence is explored in this study according to experts' perspectives."

Research Procedures

1. Research Approach

Based on the nature of the phenomenon under study and the aim the present study seeks to achieve, a qualitative phenomenological approach was adopted. This approach is concerned with understanding human phenomena by exploring individuals' lived experiences and uncovering the meanings and interpretations they construct in light of their experiences and interactions with those phenomena (Creswell & Poth, 2018). It also allows the researcher to move from the surface description of individual experiences to the extraction of shared meanings that reflect the essence of the phenomenon under study (Moustakas, 1994). The phenomenological approach is well suited to the present study because it makes it possible to draw on the diverse academic and professional experiences of experts in university education, educational technology, and artificial intelligence, and to understand their perceptions of how the use of generative artificial intelligence (GenAI) can move beyond improving certain immediate educational practices toward enhancing the sustainability of the educational system in higher education institutions. To achieve the study's aim, semi-structured interviews were used to give experts the opportunity to express and interpret their views in light of their professional experiences and practices related to technological transformations in university education. The interview guide comprised a set of open-ended questions aimed at exploring the potential of GenAI and its possible roles in enhancing educational sustainability, with room for probing questions according to the nature of each participant's responses, thereby allowing new dimensions of the phenomenon to be explored without confining it to predetermined categories. The interviews were conducted individually via Zoom in preparation for the analysis of the qualitative data, the identification of patterns of convergence and divergence in the experts' perspectives, and the derivation of the main and subthemes reflecting the potential roles of GenAI in enhancing educational sustainability, with the aim of building a conceptual framework grounded in the study's findings.

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2. Participants

Twelve experts with academic and professional experience in educational technology, artificial intelligence, and the development of university education participated in the study. Participants were selected through criterion-based purposive sampling, which involves selecting individuals who possess experience and knowledge closely related to the phenomenon under study, thereby yielding rich and in-depth qualitative data (Patton, 2015).

The selection of participating experts was based on a set of criteria consistent with the nature and objectives of the study, as follows:

- Holding a doctoral degree in a field related to the study topic.
- Having at least five years of academic or professional experience in higher education institutions.
- Having research or practical experience in the use of GenAI in university education.
- Having participated in projects or initiatives aimed at developing or improving the quality of university educational practices.
- Ensuring diversity of disciplines, experiences, and academic and professional roles across the group of participants.
- Providing voluntary and informed consent to participate in the study.

The participant selection process also followed a sequence of procedures to ensure that participants' expertise was appropriate to the nature of the study, as follows:

- Compiling a preliminary list of potential experts whose research interests and academic and professional practices relate to the study topic.
- Reviewing the potential experts' curricula vitae, academic profiles, scholarly output, and professional contributions to verify that they met the selection criteria.
- Contacting the experts who met the criteria and informing them of the study's aim and the nature of the participation expected of them.
- Verifying participants' backgrounds and experience related to the use of GenAI and the development of university education through a preliminary data form.
- Selecting twelve (12) experts, taking into account the diversity of their disciplinary backgrounds and professional experiences so that the phenomenon could be explored from multiple perspectives.
- Obtaining participants' informed consent and coordinating with them to conduct the individual interviews.

The number of participants was not determined by considerations of statistical representation, but by their capacity to provide rich qualitative data commensurate with the specificity and depth of the phenomenon under study. This is consistent with the concept of information power, which links the adequacy of the number of participants in qualitative research to the specificity of their experience, the clarity of the study aim, the quality of the dialogue with them, and the analytic strategy adopted (Malterud et al., 2016). The selection of participants also sought to integrate educational, technical, and institutional experience, which supports the outputs of the thematic analysis, allows the convergence and divergence in the experts' perspectives to be revealed, enables the main and subthemes emerging from the data to be derived,

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and supports an integrated understanding of the potential roles of GenAI in enhancing educational sustainability in higher education institutions.

3. Semi-Structured Interview Instrument

The study relied on the semi-structured interview as a tool for collecting qualitative data from experts, owing to its capacity to explore participants' perceptions and interpretations of the phenomenon under study and to yield data characterized by depth and epistemic richness (Ruslin et al., 2022). It also offers the researcher the flexibility to steer the dialogue and pose probing questions that help reveal new aspects of the phenomenon according to the nature of participants' responses (DeJonckheere & Vaughn, 2019). The interview guide was developed in light of the research problem and aim and in a manner consistent with the phenomenological approach, in order to explore experts' perspectives on the potential roles of GenAI in enhancing educational sustainability in higher education institutions, drawing on their academic, research, and professional experience.

In preparing the interview guide, care was taken to move gradually from exploring the experts' backgrounds and experiences with GenAI in university education to discussing its potential for enhancing educational sustainability and identifying how this potential can be used to bring about sustainable educational improvements. The questions were also formulated in an open and neutral manner, without presupposing specific roles for GenAI, so that the roles and the main and subthemes could emerge from the qualitative data themselves. Examples of the questions included in the interview guide are:

- How would you describe your academic or professional experience in using GenAI in university education?
- What does educational sustainability mean to you in the context of higher education institutions?
- In light of your experience, how do you see the potential for GenAI to contribute to enhancing educational sustainability?
- Which educational practices and processes do you believe GenAI can help sustain, and how might this be achieved?
- Can you describe educational situations or practices you have experienced that reflect the potential for using GenAI to achieve sustainable educational improvements?
- How can the use of GenAI move from achieving immediate educational benefits to achieving sustainable educational benefits?
- How can GenAI contribute to strengthening the university educational system's capacity to meet future changes and challenges?
- What roles do you expect GenAI to play in the future in enhancing educational sustainability?
- Which factors do you believe may enhance or limit the contributions of GenAI to educational sustainability?
- Are there other roles of GenAI in enhancing educational sustainability that you believe have not received sufficient attention?

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These questions were used as a flexible guiding framework for managing the dialogue with the experts rather than as a fixed set of questions to be asked in a set order. The interviews included probing questions to increase clarity, such as "How can that be achieved?", "What is the basis for this view?", "Can you give an example from your experience?", and "How can this role be sustained over the long term?" These questions made it possible to explore the rationales underlying the experts' perspectives, understand the contexts in which those perspectives were formed, and reveal points of convergence and divergence among them. Interviews were conducted individually with the twelve experts, with each participant given the opportunity to express their views freely and to add aspects not included in the initial interview guide. This procedure aimed to obtain qualitative data characterized by richness and diversity of information, thereby supporting the coding and thematic analysis processes and contributing to the derivation of a conceptual framework that reflects the potential roles of GenAI in enhancing educational sustainability.

4. Procedures for Conducting the Semi-Structured Interviews

The procedures were implemented through a set of organized steps, designed to be consistent with the phenomenological approach and to ensure the collection of rich qualitative data reflecting the experts' perspectives on the roles of GenAI in enhancing educational sustainability, as follows:

- **Recruiting participants and verifying their suitability.** A group of potential experts was contacted, their academic and professional backgrounds were reviewed, and their fulfillment of the predetermined participation criteria was verified. This procedure resulted in the selection of twelve (12) experts with experience directly related to the study topic.
- **Preparing participants.** Experts were informed of the study's aim, the intended meaning of educational sustainability, and the boundaries of its treatment in the present study, without being given any preconceptions about the roles of GenAI in enhancing it, so as to avoid influencing their responses or steering them toward specific themes.
- **Obtaining informed consent.** Informed consent was obtained from each participant, with clarification of the nature of the interview, the voluntary nature of participation, the right to withdraw, the confidentiality of the data, and the restriction of its use to research purposes, along with permission to record the interviews.
- **Scheduling and conducting the interviews.** Interview times were arranged individually with the experts at their convenience, and the interviews were conducted in Arabic via Zoom, providing a flexible environment for dialogue, the exchange of perspectives, and the discussion of examples drawn from their professional experience.
- **Opening the interviews.** Each interview began with a discussion of the participant's academic and professional background and the nature of their experience and practices related to the use of GenAI in university education, in order to understand the context underlying their view of the phenomenon under study.
- **Exploring potential roles.** Experts' perspectives on the potential of GenAI to enhance educational sustainability were explored progressively, with participants

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asked to clarify the nature of the roles they proposed and how these roles are realized, and to provide examples and evidence drawn from their academic and professional experience.

- **Using probing questions.** Probing questions were employed to uncover the rationales underlying the experts' views, to explore the relationships among their ideas, and to distinguish between immediate educational benefits and sustainable educational contributions, while leaving room for divergent views and critical opinions.
- **Recording and note-taking.** The interviews were recorded after obtaining participants' consent, and research notes were taken on salient ideas and emerging issues that arose during the dialogue and used to deepen subsequent discussions without steering participants' responses.
- **Transcription and anonymization.** The interview recordings were transcribed, and the transcripts were checked against the original recordings to verify the accuracy of transcription and the completeness of the data. Information that could reveal participants' identities was removed, and their names were replaced with the codes E1 to E12, where "E" stands for Expert.
- **Verification and preparation for analysis.** Participants were given the opportunity to review the transcripts of their interviews to verify the accuracy of what was attributed to them and to clarify intended meanings where necessary. The final transcripts were then organized for thematic analysis, in preparation for extracting codes and subthemes and main themes and for building a conceptual framework reflecting the roles of GenAI in enhancing educational sustainability.

Data Analysis

The study relied on thematic analysis of the qualitative data derived from the semi-structured interviews with the twelve experts, with the aim of uncovering semantic patterns and shared meanings in their perspectives on the roles of generative artificial intelligence (GenAI) in enhancing educational sustainability in higher education institutions. The analysis followed an inductive orientation, which allows codes and themes to be derived from the qualitative data themselves, while being guided by the methodological phases of thematic analysis (Braun & Clarke, 2006, 2022). The data analysis procedures were as follows:

- **Familiarization with the data.** The interview transcripts were read repeatedly and in depth in order to form a comprehensive understanding of each expert's perspective, to identify the academic and professional contexts underlying these perspectives, and to record initial notes on content related to educational sustainability.
- **Initial coding.** Units of meaning in the interview transcripts were identified and assigned initial codes expressing their content, taking care that each code related to the study's aim and preserved the original meanings intended by the participants.
- **Collating codes.** Constant comparisons were conducted among the codes extracted within each interview and across the twelve interviews, and similar codes

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were grouped into semantic categories, allowing movement from partial meanings to broader meanings that reflect the experts' perspectives.

- **Constructing main themes.** Interrelated semantic categories were organized into main themes, each expressing one of the potential roles of GenAI in enhancing educational sustainability, with attention to the nature and dimensions of each role rather than merely to how often it was mentioned in participants' responses.
- **Reviewing and refining themes.** The main themes, semantic categories, and associated codes were reviewed by returning to the original interview transcripts, in order to verify the internal consistency of each theme, the clarity of its conceptual boundaries, its distinctiveness from other themes, and its capacity to express the experts' shared and divergent perspectives.
- **Organizing analytic outputs.** An analytic matrix was prepared linking the initial codes, semantic categories, and main themes, clarifying the path from raw data to the main roles and strengthening the traceability of the findings and the verification of their links to their original sources.

In light of this analytic process, the six proposed roles were organized into the following main themes:

- **Continuity:** Ensuring that educational processes continue without interruption.
- **Quality:** Maintaining and improving the quality of educational practices and outcomes.
- **Accessibility:** Expanding opportunities for access to education and educational resources.
- **Renewal:** Continuously developing educational content, resources, and practices.
- **Flexibility:** Enhancing the educational system's capacity to adapt to changes and challenges.
- **Lifelong learning:** Enabling individuals to continue learning and developing their capabilities across the stages of their lives.

The findings are presented supported by direct quotations from the experts' responses, using the identification codes E1 to E12 to preserve the confidentiality of their identities. Table 1 presents a map of the main themes, semantic categories, and initial codes associated with the roles of GenAI in enhancing educational sustainability in higher education institutions.

Table 1. A map of the roles of generative artificial intelligence in enhancing educational sustainability

Initial Codes	Semantic Clusters	Main Roles
Providing instructional support on demand; Providing alternatives when teaching is disrupted; Following up on learning outside the classroom; Facilitating the completion of educational activities	Continuous instructional support; Continuity of educational operations	Continuity
Personalizing explanations according to learners' needs; Providing constructive	Improving learning experiences;	Quality

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feedback; Improving the design of educational activities; Reviewing and pedagogically refining content	Improving teaching practices	
Simplifying complex content; Providing content in multiple languages; Diversifying content presentation formats; Supporting learners with diverse needs	Reducing barriers to access; Expanding participation opportunities	Accessibility
Updating educational content; Producing diverse learning resources; Repurposing existing resources; Devising new activities and teaching methods	Renewing educational resources; Innovation in educational practices	Renewal
Adapting activities to changing circumstances; Diversifying educational delivery pathways; Responding to emerging needs; Reorganizing educational practices	Adapting to changes; Responding to challenges	Flexibility
Supporting self-directed learning; Expanding opportunities for skill acquisition; Facilitating continuous knowledge updating; Supporting ongoing professional development	Learner autonomy; Continuity of cognitive and professional development	Lifelong learning

Results

1. Continuity

The initial codes associated with this theme reflect the potential of generative artificial intelligence (GenAI) to support the continuity of educational processes and to overcome some constraints related to the time and place of instruction. The codes "providing instructional support on demand" and "following up on learning outside the classroom" converged to indicate that learners can obtain educational assistance continuously, rather than only during scheduled teaching times or direct contact with the instructor. The importance of this role lies in learners' ability to continue learning when they encounter cognitive difficulties that might impede their progress on educational tasks, by obtaining additional explanations, examples, and guidance that help them move forward. One participant stated:

"Sometimes a student stops working on a task because they did not understand a particular point, and they may have to wait until the next lecture. But with GenAI, they can ask at the moment they need help, and so they can continue learning without getting stuck at that point." (E7)

The convergence of the codes "providing alternatives when teaching is disrupted" and "facilitating the completion of educational activities" reveals another dimension of continuity, related to universities' ability to keep the educational process running when circumstances affect its regularity. GenAI can be used to prepare alternative explanations, activities, and learning resources that reduce the effects of disruption

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and support faculty members' ability to continue delivering educational experiences despite changes in the conditions of delivery. One participant illustrated this:

"A university may go through circumstances that make delivering some lectures in the usual way difficult. Here, a faculty member can use AI to prepare additional explanations and alternative activities within a short time, so that students do not stop learning until things return to normal" (E1).

These codes together express continuity as the educational system's capacity to sustain the flow of educational experiences, provide learners with the necessary support, and limit the factors that may interrupt their learning. From this standpoint, the value of GenAI in enhancing the continuity of education emerges at two interrelated levels: the level of the learner and the level of the university.

2. Quality

The initial codes associated with this theme point to the role GenAI can play in the continuous improvement of the quality of educational experiences and practices in higher education institutions. The codes "personalizing explanations according to learners' needs" and "providing constructive feedback" converged to reflect the possibility of offering educational experiences that respond to individual differences among learners and help them address weaknesses in their learning. This is significant because content can be presented in different ways and at different levels suited to learners' abilities, in addition to providing feedback that helps them recognize their errors and continuously improve their performance, thereby supporting the quality of their learning. One participant stated:

"In a single lecture, it is difficult for a faculty member to explain an idea to every student in the way that suits them. But GenAI allows the student to ask for the idea to be explained in more than one way, to receive comments on their answers, and to know where they went wrong and how they can improve" (E3).

On the other hand, the convergence of the codes "improving the design of educational activities" and "reviewing and pedagogically refining content" is related to the possibility of supporting faculty members in improving the quality of their teaching practices. GenAI allows them to explore multiple alternatives for designing activities, review the appropriateness of content to learning outcomes, and develop educational tasks suited to learners' levels. The value of this role lies not merely in speeding up the preparation of content and activities, but in its capacity to provide repeated opportunities to review and improve them before they are presented to learners. One participant stated:

"I think the most important thing AI offers a faculty member is that it helps them review what they present to students. An activity I prepared may be good, but when I show it to AI, other ideas and questions I had not noticed appear, and I may discover that the activity needs modification in order to achieve the goal I set for it" (E6)

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These codes together express quality as a continuous improvement process that involves both parties to the educational process. For the learner, GenAI can help improve educational experiences and make them more relevant to individual needs; for the faculty member, it can support their ability to review and develop their teaching practices. Hence, the contribution of GenAI to educational sustainability is tied to its capacity to support the continuous improvement of the quality of education, rather than being limited to temporary improvements in instructional performance.

3. Accessibility

The initial codes associated with this theme reflect the potential of GenAI to reduce the barriers that prevent some learners from accessing educational content and experiences. The codes "simplifying complex content" and "providing content in multiple languages" converged to indicate the possibility of overcoming some cognitive and linguistic constraints that may affect learners' ability to benefit from educational resources. GenAI makes it possible to re-present content at different levels of complexity, explain terms and concepts, and translate educational content into multiple languages, thereby widening opportunities for learners from diverse cognitive and linguistic backgrounds to benefit from it. One participant stated:

> "Sometimes scientific content is available to the student, but they cannot benefit from it because of the difficulty of the language or the terminology used. GenAI allows them to ask for the content to be simplified or explained in their own language, and this helps them benefit from educational sources they previously found difficult to engage with." (E12)

The convergence of the codes "diversifying content presentation formats" and "supporting learners with diverse needs" reflects the possibility of enhancing access to education by re-presenting educational resources in multiple forms suited to learners' needs. GenAI applications can be used to convert textual content into audio or visual content, provide descriptions of images, and adapt the way information is presented, which can increase participation opportunities for learners who may have difficulty engaging with traditional content formats. One participant explained:

> "Not all students can engage with content in the same way; one student needs to hear the content, and another needs to see it in an image or diagram. What distinguishes GenAI is that it helps us present content in more than one form without having to fully reproduce it for each group of students." (E9)

These codes together express accessibility as the educational system's capacity to expand effective access to educational experiences and resources and to reduce the barriers that prevent learners from benefiting from them. From this standpoint, the contributions of GenAI are not limited to increasing the available educational resources; they extend to enhancing the usability of those resources by diverse groups of learners, thereby supporting equality of educational opportunity as one of the foundations of educational sustainability.

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4. Renewal

The initial codes associated with this theme reflect the potential of GenAI to support the continuous renewal of the educational system in line with rapid epistemic and technological developments. The codes "updating educational content," "producing diverse learning resources," and "repurposing existing resources" converged to indicate the possibility of moving beyond the static nature of some educational resources and turning them into resources that can be continuously developed and updated. This role is important in helping faculty members review and update existing educational content, enrich it with new examples and applications, and re-present it in different educational contexts, thereby preserving its currency and relevance to evolving educational needs. One participant illustrated this by saying:

> "In some courses, we may keep using the same content for several years, even though new information and applications have emerged in the field. GenAI helps the faculty member review the content and suggest aspects that can be updated, add contemporary examples, and make use of existing content rather than starting to prepare it from scratch." (E8)

The code "devising new activities and teaching methods" reveals another dimension of renewal, related to the possibility of moving beyond routine practices and reconsidering how educational experiences are designed and delivered. GenAI allows faculty members to explore diverse alternatives for teaching practices, generate ideas for innovative activities and learning situations, and try out new ways of organizing learning. The importance of this role lies in strengthening faculty members' capacity to continuously renew their practices rather than confining themselves to the methods they are accustomed to using.

> "Sometimes I find myself repeating the same activities in teaching the course every year, but when I discuss a particular topic with AI, it suggests ideas for activities I had not thought of before. I may not use these ideas as they are, but I benefit from them in developing my activities and trying different ways of teaching." (E11)

These codes together express renewal as the educational system's capacity to continuously develop its components and practices, so as to prevent them from becoming outdated or rigid. From this standpoint, the value of GenAI in enhancing educational sustainability lies in supporting the epistemic renewal of educational resources and the pedagogical renewal of teaching practices, thereby maintaining the vitality of the educational system and its alignment with future developments.

5. Flexibility

The initial codes associated with this theme point to the potential of GenAI to strengthen the educational system's capacity to adapt to its surrounding changes. The codes "adapting activities to changing circumstances" and "diversifying educational delivery pathways" converged to reflect the possibility of moving beyond fixed instructional designs that may not suit all circumstances and contexts. GenAI allows faculty members to develop multiple alternatives for educational activities and to

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redesign educational experiences to suit different modes of instruction without compromising the targeted learning outcomes. In this context, one participant stated:

> "I may design an educational activity on the assumption that students will attend in the classroom, then find that circumstances have changed and I need to deliver the activity online. Using AI, I can redesign the activity to suit the new situation while preserving the educational goal I was seeking to achieve." (E10)

The convergence of the codes "responding to emerging needs" and "reorganizing educational practices" reveals another dimension of flexibility, related to universities' capacity to respond to challenges and requirements that arise during the implementation of the educational process. GenAI can be used to suggest alternatives for addressing educational problems and to reorganize tasks and teaching practices according to emerging needs. The importance of this role lies in narrowing the time gap between the emergence of a need for change and the ability to respond to it. One participant illustrated this:

> "Sometimes we discover during the course that the plan we set at the beginning does not suit the students' level or needs. AI helps us think of alternatives and rearrange activities and tasks quickly, instead of continuing to implement the same plan even though it is no longer appropriate." (E1)

These codes together express flexibility as the educational system's capacity to reshape its practices and respond to changes and challenges without losing its ability to achieve its goals. From this standpoint, the value of GenAI in enhancing educational sustainability lies in supporting the shift from fixed educational practices to practices that are more adaptable and responsive, thereby strengthening higher education institutions' capacity to deal with changing conditions and future requirements.

6. Lifelong Learning

The initial codes associated with this theme highlight the possibility of using GenAI to support learning as a continuous process that extends beyond university study. The codes "supporting self-directed learning" and "expanding opportunities for skill acquisition" converged to reflect the possibility of strengthening learners' autonomy in identifying their learning needs, choosing learning topics, and acquiring new knowledge and skills according to their interests and goals. GenAI offers learners opportunities to explore multiple fields of knowledge and to obtain guidance and assistance while learning them, which strengthens their ability to continue learning outside formal educational frameworks. One participant stated:

> "Today's student does not have to wait for a new course to be offered in order to learn a skill they need. They can use AI to determine what they need to learn, draw up a plan that suits their level, and then practice it gradually. I believe this practice can stay with them even after they graduate from university." (E6)

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The convergence of the codes "facilitating continuous knowledge updating" and "supporting ongoing professional development" reveals another dimension of lifelong learning, related to individuals' ability to keep pace with successive developments in their disciplines and professional practices. GenAI can be used to explore emerging knowledge, identify skill gaps, and suggest professional development pathways suited to individuals' changing needs. This role grows in importance amid rapid transformations that make the knowledge and skills acquired during university study insufficient to meet all future professional requirements.

> "As university professors, we constantly need to update our knowledge, especially since some fields change very quickly. AI helps me explore new topics, identify the aspects I need to develop, and suggest sources I can consult, and this makes my professional development part of my daily practice." (E2)

These codes together express lifelong learning as a continuous process of building knowledge, renewing skills, and developing capabilities that transcends the temporal and institutional boundaries of formal education. From this standpoint, the value of GenAI in enhancing educational sustainability appears in supporting individuals' autonomy in learning, enabling them to continue their cognitive and professional growth, and responding to evolving requirements across the different stages of their lives.

Discussion of the Findings

1. Continuity

The findings of the present study indicate that GenAI can play a role in strengthening the continuity of university education by providing learners with uninterrupted instructional support and by supplying educational alternatives that help keep the educational process going when circumstances impede its regularity. This can be explained by the interactive nature of GenAI applications, which allow learners to obtain assistance and guidance when needed, without being fully tied to scheduled teaching times. This finding is consistent with Kestin et al. (2025), who found that AI-supported tutoring improved student learning in less time compared with in-class active learning, which supports the possibility of using intelligent tutoring systems to provide supportive learning experiences outside traditional classroom contexts. From the perspective of higher education sustainability, the finding is also consistent with Coelho and da Silva (2026) on higher education in times of conflict and disruption, and the related need to strengthen universities' capacity to face circumstances that threaten the performance of their educational functions. The present study adds to these orientations by viewing GenAI as a potential technical approach to enhancing the continuity of education, whether by sustaining an individual's learning or by supporting the continuity of educational practices at the institutional level.

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2. Quality

The findings reveal the potential contribution of GenAI to enhancing the quality of university education, by improving the educational experiences offered to learners and supporting faculty members in developing their teaching practices. This finding can be explained by the potential of GenAI to personalize content and feedback according to individual educational needs and to offer multiple opportunities to review and improve content and activities. It is consistent with Chen and Cheung (2025), whose meta-analysis of 57 studies revealed positive effects of GenAI on university learning outcomes, particularly academic achievement, language skills, higher-order thinking, and motivational and affective aspects, although these effects varied with the conditions of implementation. From the perspective of educational sustainability, the finding is also consistent with Cresp-Barria et al. (2026), who examined the relationship between quality assurance and educational sustainability in university teacher education programs and offered an evidence-based framework linking institutional processes, academic outcomes, and continuous improvement. Accordingly, the contribution of GenAI to the quality of education can be viewed as one of the inputs that support continuous improvement processes, provided that its outputs are subjected to human review and verified for their suitability to educational goals, so that the improvements associated with its use are not merely temporary.

3. Accessibility

The findings reflect the possibility of using GenAI to widen access to university education by reducing some of the cognitive, linguistic, and technical barriers that prevent learners from benefiting from educational experiences. This can be explained by its capacity to rephrase, simplify, translate, and present content in diverse forms that respond to learners' differing needs. This finding is consistent with Pierrès et al. (2025), who explored the experiences of 33 university students with disabilities in using GenAI and whose results pointed to the opportunities it offers in learning, reading, writing, research, and self-regulation, while stressing the importance of addressing the accessibility challenges associated with these applications themselves. It is also consistent with Filippou et al. (2025), whose systematic review of the literature on inclusion in higher education revealed the importance of institutional practices and policies that address barriers related to curricula, teaching, learning, and access. In light of this, GenAI can be viewed as a potential means of supporting educational inclusion, by moving from merely providing educational resources to enhancing their usability by diverse groups of learners, thereby supporting educational equity as one of the foundations of educational sustainability.

4. Renewal

The findings indicate that GenAI can contribute to enhancing educational renewal by supporting the updating of educational resources and content and the development of teaching practices. This can be explained by the generative capabilities of these applications, which allow faculty members to explore diverse alternatives for presenting content and designing activities and to repurpose existing resources in

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renewed educational contexts. This finding is consistent with Belkina et al. (2025), whose systematic review of applied studies on the use of GenAI in higher education demonstrated the diversity of its potential uses in educational practice and offered a guiding framework for integrating it into teaching practices. It also agrees with Cheng et al. (2026), who examined sustainable teaching innovation in higher education and revealed the importance of organizational learning, faculty professional development, and digital leadership in supporting the continuous renewal of educational practices. It can be inferred that the value of GenAI in achieving educational sustainability is related not only to its capacity to produce new educational resources, but also to its potential to support a culture of continuous renewal and to keep educational content and practices relevant to epistemic and technological developments.

5. Flexibility

The findings highlighted the potential contribution of GenAI to strengthening the flexibility of the educational system, by supporting its capacity to adapt to changing conditions and respond to emerging educational needs. This can be explained by the capacity of GenAI to produce diverse alternatives for content, activities, and learning pathways, which helps faculty members reorganize their practices according to the requirements of different educational contexts. This finding is consistent with Tilwani et al. (2026), whose qualitative synthesis of research evidence on the potential of GenAI for personalizing learning and developing skills in higher education in developing countries also addressed the social and technical challenges and the strategies that support inclusive and sustainable use of these applications. From the perspective of higher education sustainability, it is also consistent with Leal Filho et al. (2026), who examined the preparedness of higher education institutions for the risks and disruptions associated with climate change and stressed the importance of adopting institutional strategies that strengthen their capacity to adapt and withstand. Although the challenges addressed in that study differ in nature from the context of the present study, it confirms the importance of institutional flexibility in achieving sustainability. The present study adds to this by highlighting GenAI as a potential tool that can be used to enhance responsiveness to change and to reshape educational practices according to evolving conditions.

6. Lifelong Learning

The findings point to the possibility of using GenAI to enhance lifelong learning, by supporting individuals' autonomy in learning and providing renewed opportunities to acquire knowledge and skills and to engage in continuous professional development. This can be explained by the capacity of GenAI applications to help individuals identify their knowledge needs, explore new fields, and develop learning pathways that suit their personal and professional goals. This finding is consistent with Zagami (2026), who examined the use of GenAI in the participatory design of educational programs that prepare learners for the future of work and highlighted its potential to support the development of programs responsive to emerging professional skills. It is also consistent with Jallali et al. (2026), who examined the relationship between AI-

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supported learning tools and educational sustainability, highlighted the importance of learning engagement and digital resilience in this relationship, and addressed lifelong learning and continuous adaptation within their theoretical conceptualization of educational sustainability. In light of this, lifelong learning can be viewed as one of the extended roles of GenAI, which is not limited to supporting learning during university study but also includes strengthening individuals' capacity to continue their cognitive and professional growth after graduation and to respond to rapid transformations in fields of knowledge and work.

Recommendations

In light of the findings, the researcher recommends the following:

1. Developing institutional strategies for employing GenAI to enhance educational sustainability, linked to measurable and monitorable performance indicators.
2. Integrating GenAI applications into university learning management systems to provide continuous instructional support and to enhance the accessibility of educational content for different groups of learners.
3. Implementing ongoing professional development programs for faculty members, to enable them to use GenAI to improve and renew the quality of educational practices.
4. Employing GenAI in developing educational continuity plans and designing flexible educational alternatives that respond to crises, changes, and emerging educational needs.
5. Developing flexible learning pathways supported by GenAI, aimed at enhancing self-directed learning and continuous cognitive and professional development for students and graduates.

Suggested Future Research

1. The effectiveness of a GenAI-supported learning environment in enhancing educational sustainability among higher education students.
2. Developing a scale of GenAI-supported educational sustainability in higher education institutions and verifying its psychometric properties.
3. Challenges of using GenAI to enhance educational sustainability in higher education institutions and ways to overcome them.
4. Developing an institutional model for using GenAI to enhance educational sustainability in universities and measuring its effectiveness.

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