2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC

Host Sponsor UNC Charlotte

Paper ID #50318

AI in Construction Education Programs: Addressing Accessibility and Reliability through a Comparative Case Study

Luciana Debs, Texas State University

Luciana Debs, is an Assistant Professor of Construction Management in the Engineering Technology Department at Texas State University. She received her PhD from Purdue University Main Campus, her MS from the Technical Research Institute of Sao Paulo and her Bachelor's in Architecture from the University of Sao Paulo. Her current research includes the technology and teaching within design and construction and the impact of Construction and Education 4.0 in undergraduate curriculum.

Dr. Kimberly Grau Talley P.E., Texas State University

Dr. Kimberly G. Talley, P.E. is an associate professor in the Department of Engineering Technology, PERSIST (Promoting the Engagement and Retention of Students In STEM) Lab Director at Texas State University, and a licensed Professional Engineer. She received her Ph.D. and M.S.E. from the University of Texas at Austin in Structural Engineering. Her undergraduate degrees in History and in Construction Engineering and Management are from North Carolina State University. Dr. Talley teaches courses in the Construction Science and Management and Civil Engineering Technology Programs, and her research focus is in student engagement and retention in engineering and engineering technology education. Contact: talley@txstate.edu

Alex Souza

AI in Construction Education Programs: Addressing Accessibility and Reliability through a Comparative Case Study

Introduction

Artificial Intelligence (AI) can be understood as a general-purpose technology (GPT). GPT is a term created by researchers from the field of economics to define technologies that greatly change our personal and professional lives [1]. GPTs are disruptive technologies with broad applications and that foster changes across a wide range of fields [2]. Previous research indicates that over time, AI could be as disruptive as key technologies in human history, such as the steam engine and computers [3]. Therefore, AI has the potential to change and improve human productivity in many sectors, including construction and construction education [4], [5].

One key student learning outcome for related undergraduate programs is to provide students with applied knowledge in technology that can assist them with the management of the construction process [6]. Therefore, preparing students for an AI-embedded future is key for their professional success [7]. Yet, many programs still face challenges in the use and teaching of AI in construction. In a recent survey of construction educators from the United States and abroad, results showed that efforts to integrate AI into teaching of construction education is still low, even though instructors' awareness of the topic is not low [5].

AI in construction education is a trending topic, as is AI in higher education in general. Several research papers acknowledge the importance and the benefits of teaching with and about AI in higher education, while others highlight competencies necessary for the future of AI in industry [8], [9], [10]. While the benefits seem vast, previous research also has raised concerns related to ethics, curriculum integration, infrastructure accessibility, tool cost, and instructor training in the adoption of AI in higher education [8], [9], [11].

The main objective of this work in progress paper is to add to the discussion of implementing Artificial Intelligence in higher education, construction-related programs, focusing specifically on identifying challenges related to its access and reliability. In this paper, the use of AI will be delimited to AI-powered chatbots, such as ChatGPT, Perplexity, Claude and Gemini. Given that construction-related content is highly technical and location based, it is unclear how reliable these tools would be to support student learning. Moreover, it is also unclear how instructors can effectively integrate these tools to support students learning, when considering tool accessibility. For example, should students use third-party tools or should tools be provided by their institution? Who will be responsible for the costs associated with accessing and maintaining these tools? Who should be instructing students about how to effectively use these tools? Could AI-chatbots be used to responsibly improve content accessibility for higher education students?

To address this gap, the present paper starts with a scoping review of key challenges for the adoption of AI-chatbots in higher education programs, focusing specifically on construction and civil engineering programs, including ethics, curriculum integration, infrastructure accessibility, tool cost considerations, and instructor training. Ethics related to academic dishonesty and plagiarism will not be included in this review because these are not the focus of the present study. Moreover, previous research on these issues is considerable. For examples, see Khalil and Er [12], and Lund et al. [13].

Following, we use a comparative case study of challenges related to the future application of an AI-based conversational agent in three classes across two institutions of higher education – one in north and one in South America. Instructors from these three courses provide feedback on the creation and evaluate their planned AI-embedded technology against the accessibility and reliability concerns identified through the scoping review. Our findings will stress considerations for the future application of AI in support of student learning by construction programs.

Methodology

This paper utilizes a 2-phase, sequential approach. In Phase 1, we performed a scoping review using Scopus to identify literature that could address concerns and considerations in the use of AI-chatbot related to access and reliability. The goal of the scoping review was to identify concerns and considerations that inform guiding questions for Phase 2.

The research team chose Scopus as the database of choice for the initial search. The following is a list of keywords used to search title, abstract and keywords: (“AI chatbots” OR (“AI” AND “conversational agents”) OR (“AI” AND “virtual tutor”) OR “LLM” OR “AI agent”) AND (“higher education” OR “undergraduate education” OR “graduate education”) AND (“accessibility” OR “inclusive education” OR “reliability” OR “trust” OR “content availability”). We also have removed any documents with undefined authors and limited our search to English language, journal, review and conference articles. This initial search yielded 205 documents. Following, three steps of screening were performed. First, the documents’ titles were screened for suitability, resulting in 82 documents. We note several titles excluded in this step because they were related to patient education in the medical field. Secondly, the remaining 82 documents’ abstracts were reviewed to remove those unrelated to undergraduate education, conversational agents and adoption challenges, resulting in 53 documents. Finally, the remaining documents had their full text assessed for fit to the study’s objectives, during which we removed 14 for only containing minor notes on accessibility and reliability issues, 8 for focusing mainly on adoption issues, 3 for lacking quality or results information, and 7 for other various reasons. The research team could not access one of the full papers, which was then excluded from the analysis. Figure 1 summarizes the steps in the data collection.

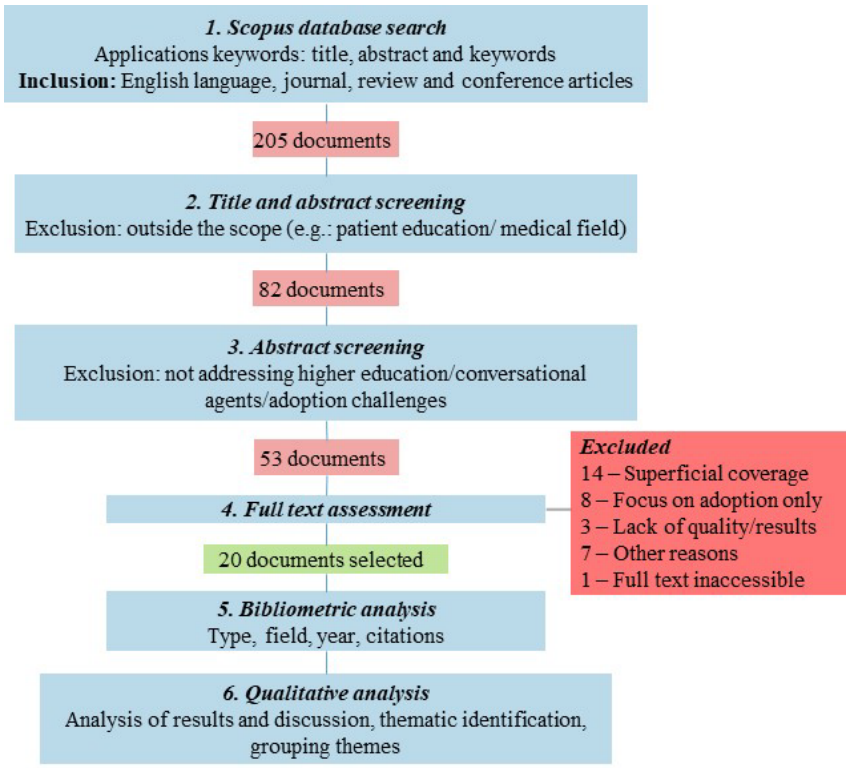

Figure 1. Flowchart of scoping review data collection and analysis

The final set of 20 papers were used for analysis. First, a brief bibliometric review is performed, providing frequencies for type of paper, field, year of publication, and citations. Following, qualitative analysis was performed on the 20 papers, identifying emerging accessibility and reliability challenges and suggestions, and then grouping them into major themes for reporting. For this qualitative analysis, only results and discussion sections were analyzed. The results from Phase 1 also informed the creation of a questionnaire that was reviewed by all authors.

In Phase 2, the three authors of the paper provide an independently written reflection, utilizing the developed questionnaire for guidance. The reflections provide an overview on the adoption of AI-chatbots in different construction related courses using a multiple-case study approach. The reflections were guided by questions formulated as a result of Phase 1. Findings were then compiled and coded for emerging themes by one author. The major themes were then discussed with all authors until a consensus was reached.

We acknowledge that our approach may contain biases that may limit the generalization of our findings. However, our purpose with this work in progress study is to raise the discussion about responsible and meaningful adoption of artificial intelligence into construction higher education courses. Moreover, we collect reflections from three instructors at two different higher education institutions in two different countries, mitigating some of the limitations in case-study methodology. By connecting reflections and previous research, we aim to be better able to evaluate student impact in the future.

Results of Scoping Review

Twenty papers were selected for analysis. Growth was trending upward for the first three years since 2023 (n_{2023}=4, n_{2024}=4), with a dramatic increase in numbers in 2025 (n= 12), which was only considered until mid-October. The country with most author affiliations per paper is the United States (n=4), followed by United Kingdom, China and United Arab Emirates (each with n=3). A series of other 31 countries are represented in authors' affiliations in either one or two publications, showing how AI chatbots in education represents worldwide interest.

Moreover, 16 papers are journal articles, while four were published in conference proceedings. Even though all selected papers were from the past four years, some of them already have high citation counts (see Table 1), making the average set have approximately 58 citations per paper. Most of the analyzed papers utilized a review methodology (n=7), followed by survey or quasi-experiments (n=4 each), and interviews. One study utilized a collective writing methodology with a panel of experts, and another one utilized a review methodology process (AHP) with expert validation.

Table 1. Top 5 most cited articles as of November 2025

Paper	Number of Citations
Rasul et al. [14]	401
Dempere et al. [15]	274
Kim et al. [16]	116
Ding et al. [17]	108
Williams [18]	89

There were no papers related to construction or civil engineering education among the sample. In fact, most papers (n=14) were either general to higher education or used sample from a wide range of academic fields. Two papers were related to English, one as a foreign language [19] and one in academic writing [16]. Four were related to science, technology, engineering and mathematics (STEM) education, including one on physics [17], one in electrical engineering [20], one in general STEM [21] and one with a mixed sample of engineering and business students and faculty [22].

Co-occurrence analysis with the top 25 merged authors' and index keywords resulted in three clusters (Figure 2). Cluster (i) focuses on ethical, legal, and decision-making issues associated with artificial intelligence, indicating a regulatory and normative focus. Cluster (ii) location is central and relates to generative artificial intelligence, in which generative AI and chatbots act as articulating elements. Finally, cluster (iii) represents research foci of AI in higher education, including research on students, faculty, assessment, curriculum, and the integration of AI into educational practices. The central position of generative AI indicates its integrating role across different themes, while also revealing weak integration between the ethical-regulatory and educational clusters, highlighting significant gaps in the systematic legal and ethical foundations of AI applications in education. In summary, the results suggest that the advancement of applications in higher education has occurred in a disconnected manner between pedagogical

innovations and responsible regulation and decision-making.

Figure 2. Co-occurrence network analysis for top 40 keywords

Following, we present the results from the thematic analysis. First, we describe the major challenges found in the articles and then make suggestions from papers to address some of these limitations. We note that, despite excluding papers solely focused on AI and academic dishonesty and plagiarism, we still identified a theme related to this topic, highlighting its importance for instructors considering integrating AI into their teaching and assessment procedures.

Four major themes related to reliability and accessibility challenges were found within the 20 analyzed papers. These challenges relate to technology adoption, cognitive development, ethics and dehumanization. Each of these had subthemes which are included in table 2 and Figure 3.

Table 2. Emerging themes and subthemes for challenges (n=20)

Major Themes (frequency)	Subthemes (frequency)
Cognitive development (n=18)	Overreliance (n=16)
	Incorrect or incomplete answers (n=15)
	Reduced critical thinking (n=13)
	Reduced originality and creativity (n=7)
Ethics (n=17)	Other (including general) ethical concerns (n=14)
	Privacy and security concerns (n=12)
	Algorithmic biases (n=11)
	Plagiarism and academic dishonesty (n=11)
Adoption (n=16)	Uneven access to technology and infrastructure (n=11)
	Lack of formal training (n=10)
	Frustration during chatbot interaction (n=5)
	Cultural resistance to change (n=1)
Dehumanization (n=13)	Lack of human interaction/social skills (n=9)
	Devaluation of teaching roles (n=5)
	Reduced teacher-student trust (n=3)
	Lack of pedagogy (n=1)

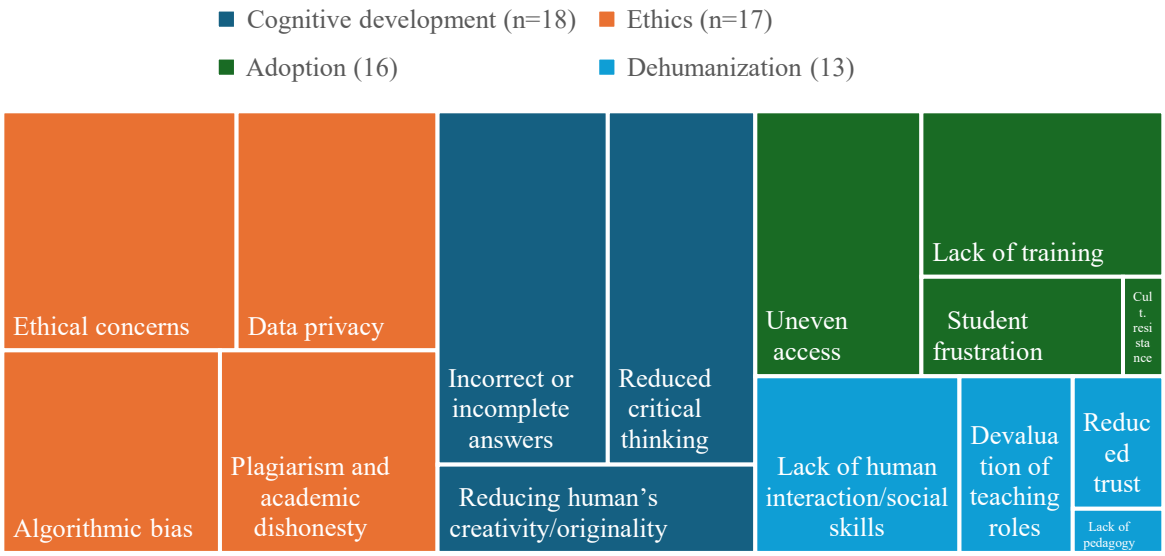

Figure 3. AI-chatbot challenges emerging themes distribution

Challenges related to cognitive development are the risk of overreliance, mentioned by 16 analyzed papers. Issues of overreliance were brought up by multiple data points, including students, instructors, researchers and review papers [17], [23], [24], [25]. Moreover, previous research by Bozkurt et al. [24] highlights that overreliance on AI-based chatbots can lead to vulnerabilities that can be exploited by malicious agents. The same authors caution that overreliance may lead to reduced human agency, as more decisions are delegated to AI-chatbots. Additional concerns arise from students' compulsive use of AI-chatbots, which could lead to emotional issues [23]. This subtheme is particularly concerning when combined with incorrect or incomplete answers and reduced critical thinking, as some students cannot catch chatbots' mistakes.

Mentioned by 15 papers, incorrect or incomplete answers are a frequent concern. These errors are known as hallucinations, and although improvements are constantly being made to refine models and reduce hallucinations, students are particularly at risk because they might not be able to catch the mistake [17], [26]. When students are not able to identify issues in chatbot's answers, they may inadvertently contribute to the spread of misinformation [24], [27] or even sabotage their own learning by propagating misconceptions [17], [18], [19]. Risk of learning complications can be seen in the study by Ding et al. [17] during which participants interacted with AI-chatbots and, during the interaction (through a conversation) the bot changed correct to incorrect answers.

Another concern of 13 papers relates to reduced critical thinking. Abdallah et al. [23] mentioned that the use of AI-chatbots lowers the cognitive load in students, which may be a good thing, however it seems this reduction is at the cost of reasoning and argumentation. The overuse of AI-chatbots may lead to shallow reasoning, because the models usually do not provide deep

reasoning themselves, and issues when problem solving or using higher-order skills, such as synthesizing, evaluating and creating with information [19], [24], [25], [27], [28].

In addition to reduced cognitive development, seven papers mentioned that use of AI-chatbots may risk reducing human's creativity and originality. This risk is because usually these developable skills require higher-order thinking and deep reasoning, and by outsourcing the creative process to AI-systems, our students do not get to learn, practice, and grow their skills [24]. Moreover, despite our thoughts of generative AI as an endless source of content, the models are still based on statistical analysis, therefore Bozurt et al. [24] warn about the risk of creating "echo chambers," in which new content may be overlook by more mainstream information. This concern is echoed by Kim et al. [16] when analyzing the use of AI-chatbots for writing. In their discussion, they highlight the issue of AI-chatbots converging in writing styles, therefore students losing their individuality.

Fourteen papers mentioned general ethical concerns in the use of AI-chatbots for learning. Within this theme, eight papers mentioned ethical concerns, without further development, while seven papers mentioned insufficient oversight over models by developers, institutions and instructors [16], [24], two mentioned the concentration of power in few private companies [24], [25], and sustainable and environmental impacts related to resources for increased infrastructure demands [24].

Following these general concerns, twelve papers mentioned issues with data privacy (especially students) and security [23], [24], [27], [29]. Security concerns included data collection on users, including material submitted to the chatbot, which can lead to increased sense of surveillance and the risk of using data to impersonate students and instructors for malicious activities, such as phishing attacks [18], [19], [24], [30].

Ethical concerns related to algorithmic bias were mentioned in 11 papers. Algorithmic bias is when models may perpetuate existing biases from training data [14], [24], [27], [31]. This code also includes concerns related to reducing cultural (and individual) differences, especially when cultural context is non-western or is from marginalized or minority populations [16], [18], [24]. Western context was largely used for training of the more well-known AI-chatbots [19], [24].

Eleven papers mentioned concerns about plagiarism and academic dishonesty. This dishonesty is mainly concerning when students submit unrevised AI-chatbot answers as their own [23], [24]. This trend may raise issues into the fairness of assessments, because some students may use AI, while others may not [14], [24]. In addition to academic dishonesty, other issues covered within this code are plagiarism, meaning the submission of student work without proper credit to sources [24], [27]. This level of dishonesty is concerning because Kamoun et al.'s [22] results show that over 50% of surveyed students indicated they do not perceive using ChatGPT without the proper attribution in their assignments as plagiarism.

In terms of adoption challenges, the most frequently mentioned challenge was uneven access, mentioned in eleven documents. This disparity is particularly concerning in regions that have unequal resource access [23], [24], [27]. Additionally, access to infrastructure may influence students' ability to use AI-chatbots. For example, Kouam and Muchowe [32] raise the concern about lack of internet access in certain areas of Zimbabwe, that can affect reliable use of AI-chatbots. Moreover, access may be expensive, when not provided by the institution to all students, and can exacerbate inequity in learning and digital divide [14], [21], [31], [32].

Following, lack of training was mentioned in half of the analyzed papers (n=10). This shortcoming includes lack of training by students and instructors [23], which hinder their ability to effectively interact with the tool for proper learning (and course design) [19], [24], [29], [30], [31].

Additionally, under adoption challenges, we highlight five papers that mentioned student frustration during AI-chatbot interactions, and one paper mentioned cultural resistance to change (mainly from educators and institutions) [31]. Student frustration occurred mainly when the chatbot failed to understand students' needs, produced inaccurate (or nonsensical), or overly lengthy and convoluted answers [20], [23], [26].

Finally, dehumanization was mentioned by 13 papers. Within this theme, nine papers identified concerns due to the lack of human interaction, which could hinder students' social and interpersonal skills [16], [23], [24], [32] and increase students loneliness [29]. An additional five papers mentioned that the increase in use of AI-chatbots may also lead to a devaluation of the teaching profession and roles [24], [25], [31]. Moreover, the pervasive use of AI-chatbots in education may lead to an erosion of teacher-student trust, as well as institutional trust in the educational process (n=3) [14], [31], [33]. Finally, Kim et al. [16] mentioned that AI-chatbots do not have the ability to reproduce the teaching process, including planning and evaluating student learning.

In addition to challenges, many of the papers (n=18) provided suggestions to address the challenges mentioned previously. Seven major themes were identified from the papers and can be found in table 3.

Table 3. Emerging themes and subthemes for suggestions (n=18)

Major Themes	Frequency
AI-Literacy training	15
Modified learning strategies	12
Clear usage guidelines	8
Measures to increase access equity	8
Install security risk mitigation strategies	6
Plagiarism detection	5
Others	4

First, addressing not only lack of training but challenges related to reduced cognitive development, is AI-literacy training (n=15). This category includes formal training and awareness campaigns that ensure the sustainability of training. Training should help students use tools meaningfully for their learning, while minimizing issues of plagiarism and academic dishonesty and can also assist instructors in effectively integrating AI-chatbots in their course design [14], [23], [27], [30]. Moreover, training should help students and instructors understand how AI large language models work, so students are better equipped to handle (and hopefully mitigate) potential algorithmic biases [25], [27], [31].

As mentioned in the previous emerging theme, AI-chatbot integration in the learning process will likely require the modification of learning and assessment strategies (n=12). These strategies included building assignments that require higher-order thinking skills [23], evaluating pilot initiatives [27], using AI-chatbots as teachable agents [16] and including more oral presentations [18]. These approaches will require institutions to facilitate the collaboration and exchange of ideas between instructors about AI-chatbot integration [28].

To address uneven access to tools and infrastructure, eight papers mentioned the need for institutions to step up their measures to increase equitable access to technology (n=8). This access includes campus-wide licenses [23], [32] and LLM-learning management system (LMS) integration [14], [30]. Developers could also assist by creating offline capable tools and voice-based chatbots, which minimize internet usage [19].

Institutions and instructors should also provide clear usage guidelines for students (n=8). These guidelines should include clarifying expectations for how to use chatbot provided information in academic assignments [27]. But also, these guidelines should focus on encouraging the use of AI-chatbots, rather than focusing on restricting it [32].

Additional suggestions included installing security measures (n=6) to reduce the risk of privacy breaches and copyright infringement [15], [18], [27], [31]. Five additional papers mentioned the need to improve plagiarism detection through software and also remote proctoring platforms [15], [18], [23], [27], [31]. Other suggestions (n=4) made included fostering multidisciplinary collaboration, given the pervasive nature of the problem [23], [31], balancing regulation with innovation, to avoid restricting the innovation cycle [27] and rethinking the nature of education [24].

Figure 4 summarizes how emerging themes under suggestions relate to the challenges mentioned previously in the literature. Our findings suggest that AI-literacy training and modified learning strategies may be more effective in addressing a wider range of AI-related challenges, compared to other suggestions emerging from literature. For example, some suggestions address very specific concerns, such as measures to increase access equity relates exclusively to uneven access. The red frames in figure 4 highlight concerns and mitigation strategies emerging from the literature review.

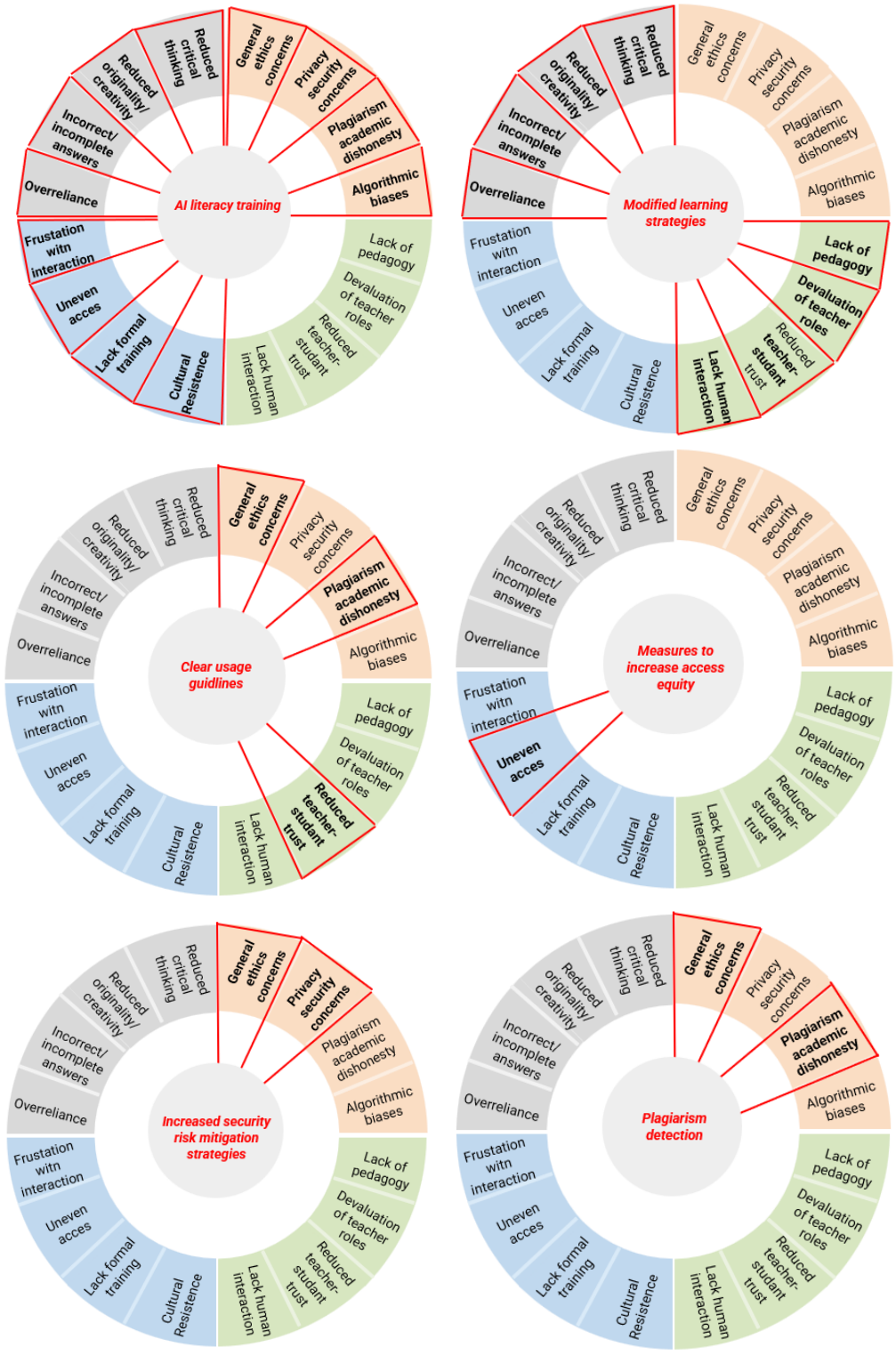

Figure 4. Relationship between identified themes in challenges and suggestions

Results of Comparative Case Study

The results of the scoping review led to the development of a 4-part (18 question) instrument that led to the reflections. This questionnaire was reviewed by all authors prior to being answered independently. Each of the four parts of the questionnaire is based on the challenges identified in the scoping review, that is, adoption considerations, dehumanization, ethics, and cognitive development. Table 4 contains the summary of each course evaluated, noting that courses B and C are from the same institution. We also note that the three courses serve different student levels and are in different AI-adoption stages, with one still in exploration stage, another with AI used by instructor and one with AI implemented to students. Following, we will present a summary of the three cases per major theme.

Adoption Challenges

Except for one mandatory assignment in Course C, AI use by students is not mandatory. Course C's mandatory assignment is linked to the exploration of AI as an emerging technology in construction and students are required to submit a pdf with the interaction the class AI-chatbot, along with a debrief. For Course A, AI use is encouraged and for research, idea generation and problem formulation. In the course, the instructor guides students, providing training to students for meaningful AI-chatbot-interaction and use. The instructors have attended events related to AI in their institutions, but none of them have received formal AI in education training. Similarly, instructors did not note any mandatory or formal institution AI-literacy training for students, although they may be encouraged to attend events or sign up for optional courses or other resources. Only one of the instructors (course C) indirectly assesses students' interest in AI through discussions about emerging technologies, mainly because due to the focus on emerging technologies in the course, there is no direct question about students' interest in using AI-chatbots.

Table 4. Courses evaluated main characteristics

Characteristics	Course A	Course B	Course C
Location of institutions	Southeastern Brazil	South Central US	South Central US
Mode of delivery	In-person	Online	Online
Course level	Undergraduate (senior)	Graduate (masters)	Graduate (Ph.D.)
Course topic	Steel Structures	Pre-Construction Services	Emerging Technologies in Construction
Stage of AI-adoption	Implemented (mainly instructor)	Exploration stage	Implemented for students
Purpose of AI use	Research, idea generation	Engagement and validation	Emerging technology exploration
Mandatory AI use	No	No	Yes (one assignment)
LMS Integration	No	Planned (TopHat)	No (external link)
Ethical framework	Instructor guidance	Institutional agreement	Institutional enterprise agreement
Risk of overreliance	Low	Low	Moderate

Integration of AI-chatbot to the learning management system (LMS) is desired in courses B and C. However, in using Perplexity AI in course C, the instructor could not embed it in the LMS and a link had to be used. Course B instructor's goal is to use Top Hat, which is an engagement platform that also uses AI and is currently supported for integration in the institutions' LMS. Course A students utilize AI-chatbots directly and not through an LMS. AI-chatbot selection for courses B and C is based on what is freely available to students through university partnerships, while Course A focuses on free versions of known AI-chatbots. Accessibility is not an issue in courses B and C because they are online, therefore students are expected to have access to the internet and compatible devices. Free internet is available on campus for students in course A, but no information is provided for offsite access.

Dehumanization

In the online courses (Courses B and C), human interaction is challenging, though the instructor in course B includes group work that will balance the use of AI. Course C does not currently have a group component. Course A utilized a team-based learning approach, to the use of AI is embedded in teamwork, therefore students can use AI-chatbots collaboratively, including debriefing of their interactions. As for making students aware of AI-limitations, course B instructor plans to use institution guidance for appropriate language and resources to use, while course C uses a discussion in which students exchange information about AI-hallucinations and elaborate the reasons for it, after they are provided with AI-related module content. In course A, the instructor explains the limitations of AI use to students and informs them that information provided by the tool must be validated and instructors should be consulted for complex structural analysis.

Ethics

The tools considered or used by courses B and C are part of an agreement with the university. The agreement protects student privacy in the uses of Top Hat and Perplexity. The latter access is for the enterprise version, and by default exclude users from AI data retention or training modules. Course A does not have specific university policies, but students are advised not to share personal or sensitive information in AI-chatbots,

In terms of guidelines, course C instructor noted that there is institutional guidance, but it is rather generic and tied to the university honor code. Additional guidance is included in the syllabus to allow for editing tools (such as Grammarly) or initial research tools (such as idea generation, brainstorming, and reading comprehension and feedback on writing style) without instructor permission, banning the use for text-generation. The university honor code is referred to by the syllabus of course B and already includes caution about submitting other's work as students' own work. Finally, course A instructor notes a lack of university-wide guidance in their institution and also mentions that, currently, there is no specific information about AI-use in the syllabus.

In terms of potential biases, instructors' responses varied greatly. While one respondent noted that the engineering focus of the course reduces the risk for algorithmic bias, another one mentioned that potential biases should be reduced due to the developed AI-tools being based on existing material, and the other indicated that the AI-chatbot may provide students with references to non-existing academic papers, which may include false information.

All instructors mentioned no tools available to reliably check for AI use. One of the instructors mentioned the availability of one AI-detection tool that exists, but it includes a disclaimer that it should not be used as a measure of academic misconduct. All courses include presentations, which may reduce the risk of misconduct. AI use disclaimer by student is not used in any course, but was deemed as an interesting suggestion by two of the instructors, while the other (course A) mentioned that this is not required of students as submissions are due at the end of each class for work performed during class, under the supervision of the instructor and AI use is optional.

Cognitive development

Testing of AI-tools by instructors is mixed, with only course C having conducted tests and identifying that chatbots may make up academic texts and references, which is why the instructor requires students to seek and read sources provided by the AI-chatbot, and not rely on summaries. However, there is no way for the instructor to easily assess if students followed this guidance. For assisting students in identifying AI-chatbot hallucination, the instructor from course B plans to have students act as the expert and validate the information provided by the chatbot.

Moreover, due to AI being a minor portion of courses A and B, instructors do not worry about the risk of overreliance. They also balance the use with other course developed content, such as textbooks, and technical standards that are the main sources of information in the course. In course C, the instructor included a mix of discussions and personal reflections to mitigate overreliance in AI. Because the course requires a short academic paper as one of the final deliverables, the instructor is thinking of alternative ways to reduce the risk of overreliance and ensuring students seek original sources for information.

In terms of reduced critical thinking, all the instructors believe that if used as planned in the course, the use of AI-chatbots will enhance students' critical thinking skills. However, the instructor for course C mentioned that they cannot check if this enhancement is the case due to the lack of reliable AI-detection tools. Moreover, due to the topics covered in the courses and how the AI tools are planned or integrated in the course, the instructors are not very concerned about the impact of AI-chatbots on students' creativity and originality. Table 5 summarizes the main findings across the courses evaluated in the case studies.

Table 5. Comparison of AI use across courses by thematic areas

Theme	Course A	Course B	Course C
Adoption considerations	Instructor-led implementation; AI encouraged for research support, idea generation, and problem formulation; no mandatory use; free versions of widely used AI chatbots; no LMS integration; campus internet available	Exploration stage; experimental use focused on engagement and validation; no mandatory use; institution-supported tools; LMS integration planned (Top Hat); online access assumed	Implemented for students; AI explored as an emerging technology; one mandatory assignment with AI interaction and debriefing; institution-supported enterprise tools; external access (no LMS integration); online access assumed
Dehumanization	In-person delivery with strong peer interaction through team-based learning; AI embedded in collaborative work and debriefing; instructor-led explanation of AI limitations	Online delivery with limited human interaction, partially mitigated through group work; limited collaborative AI use; planned reliance on institutional guidance regarding AI limitations	Online delivery with limited human interaction; no current group component; AI used mainly individually; student-led discussions on AI hallucinations
Ethics	No specific institutional AI agreements; ethical guidance provided by instructor; students advised not to share sensitive data; academic integrity supported through supervised in-class work; risk of inaccurate information acknowledged	University agreements in place ensuring data privacy; AI use aligned with honor code policies; presentations reduce misconduct risk; algorithmic bias considered limited	University agreements and enterprise-level privacy protection; generic institutional guidance complemented by syllabus-specific rules; presentations and reflective assignments; concerns with hallucinated references and fabricated content
Cognitive Development	AI is a minor course component; low risk of overreliance; emphasis on validation and instructor consultation; critical thinking expected to be enhanced; no major concern regarding creativity	AI balanced with textbooks and technical standards; students positioned as subject-matter experts to validate chatbot outputs; low risk of overreliance; critical thinking expected to be enhanced	Instructor-tested AI tools revealed hallucinations; mandatory source checking beyond summaries; moderate risk of overreliance mitigated through reflection; critical thinking expected to improve, though difficult to verify; no major concern regarding creativity

Discussion

Our results show that, despite previous research outlining many benefits to the use of AI-chatbots for educational purposes [14], [24], [32], challenges exist in terms of adoption, dehumanization, ethics and cognitive development.

Upon exploring different adoption stages of AI-chatbots in teaching in three different courses in two different institutions, we see how these challenges affect students and instructors. For example, we still see that there is a lack of training in the effective use of AI-chatbots by instructors and by students, confirming previous research by Abdallah et al. [23]. On the other hand, uneven access, which was frequently found during the scoping review [23], [24], [27], was

not a prominent concern in the courses reviewed. One of the reasons could be that the sample included two online courses, in which access to internet is already expected of students. However, it is noted that in Brazil, student access relied on a free version of AI-chatbots, while students in the US university had access to a more advanced version, as part of negotiations with AI companies and the institution.

On the issue of dehumanization, it was also found to be not as prominent. Again, this finding may be because the sample included two asynchronous online courses, in which collaboration and human interaction is already more challenging [34]; the one in-person course evaluated, utilized AI-chatbot in a very specific way and during class time, as part of collaborative problem-solving. This problem may be more acute as widespread use or reliance of AI-chatbots in courses increases.

Ethical guidance by institutions was also very loose, if at all existing, stressing the importance of training and improved and clearer guidelines (by institutions and instructors) as suggested by previous research [27]. Moreover, instructors of the courses reviewed in this paper mentioned they do not feel equipped to reliably detect AI use in submissions, despite several papers that indicate challenges in AI-related plagiarism and academic misconduct [23], [24]. Moreover, despite previous research concerns about algorithmic bias [24], [27], two of the three sampled courses did not stress potential bias as a major concern, mainly due to the technical nature of the courses.

Finally, related to cognitive development, instructors of the sampled courses confirm the lack of tangible measures of AI-chatbots in students' learning, but remain positive overall in their impressions of impact of AI in learning, mitigating some of the concerns from previous research [23], [25].

Conclusion & Recommendations

This work in progress paper reviewed the challenges of integrating AI-chatbots in construction education. Starting with a scoping review of literature, we have identified 20 papers that discuss challenges in the use of AI-chatbots in higher education. These papers highlight four emerging themes: adoptions challenges, dehumanization of teaching, ethical concerns and impacts on cognitive development. Based on these challenges, a questionnaire was developed and used to evaluate how construction education courses apply and use AI-chatbots.

By answering the developed questions, we provide insight into how three courses at two different institutions are using AI-chatbots in construction education. Our review still shows that training and guidelines for the effective use of AI-chatbots and AI in construction education are lacking, and that instructors are ill equipped to reliably detect the use of AI in student submissions. However, on the positive side, issues with access and concerns with dehumanization and cognitive development are not as prominent. Despite challenges, the use of AI-chatbots is still seen as a tool that can enhance learning, when used effectively. For instructors

of construction disciplines, our findings provide considerations for the practical use of AI in their courses, highlighting concerns that should be considered during course development. For example, our findings suggest instructors will need to revise, or at least consider, learning strategies as part of integrating AI into learning, to ensure it enhances students' cognitive development. Moreover, for administrators, it shows the need for better training instructors and students about using AI chatbots effectively for their education.

The next steps for our research include collecting instructors updated views on the deployment or expected deployment of AI integration. We also plan to capture students' feedback through course evaluation comments and reflections. We plan to collect data across two or three semesters to capture the evolving nature of AI-chatbot integration, while providing a more balanced view between instructors and students' perceptions.

Finally, to mitigate some concerns raised by our research, and also inspired by findings in our scoping review, we suggest improving AI-literacy training for instructors and students, with clearer guidelines on the use of AI-chatbots by institutions and course instructors. Institutions should strive to improve equity in the access to AI-chatbots, while mitigating security risks of its use. Construction, and higher education in general, should be prepared to re-evaluate teaching and assessment strategies to address effective learning in the age or artificial intelligence. As we move forward, our research will focus on pilot and wider implementation efforts of the use of AI-chatbots in construction education. Results should be published and discussed so that instructors are better prepared to leverage AI-chatbot benefits for student learning.

References

[1] B. Jovanovic and P. L. Rousseau, "General Purpose Technologies," in *Handbook of Economic Growth*, vol. 1, Elsevier, 2005, pp. 1181–1224. doi: 10.1016/S1574-0684(05)01018-X.

[2] A. K. Agrawal, J. Gans, and A. Goldfarb, "Introduction to 'The Economics of Artificial Intelligence: An Agenda,'" in *The Economics of Artificial Intelligence: An Agenda*, University of Chicago Press, 2018, pp. 1–19. [Online]. Available: https://www.nber.org/books-and-chapters/economics-artificial-intelligence-agenda

[3] E. Brynjolfsson, D. Rock, and C. Syverson, "Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics," National Bureau of Economic Research, Cambridge, MA, w24001, Nov. 2017. doi: 10.3386/w24001.

[4] S. O. Abioye *et al.*, "Artificial intelligence in the construction industry: A review of present status, opportunities and future challenges," *J. Build. Eng.*, vol. 44, p. 103299, Dec. 2021, doi: 10.1016/j.jobe.2021.103299.

[5] J.-Y. Cheng, A. Devkota, M. Gheisari, I. Jeelani, and B. Franz, "AI Integration in Construction Education: A Survey on Awareness, Attitudes, and Implementation of AI among US and International Faculties," *J. Civ. Eng. Educ.*, Online first 2025, doi: 10.1061/JCEECD.EIENG-2223.

[6] American Council for Construction Education (ACCE), *Document 103: Standards and Criteria for the Accreditation of Construction Education Programs*, 103, Jul. 27, 2025.

Accessed: Dec. 04, 2024. [Online]. Available: https://www.acce-hq.org/file-share/64986a9f-85ee-4383-b61f-a7222147d2fa

[7] H. S. Xie and R. R. Zore, "Exploring the Role of AI in Supporting Construction Education: Trends, Applications, and Integration," in *2025 5th International Conference on Artificial Intelligence and Education (ICAIE)*, May 2025, pp. 718–722. doi: 10.1109/ICAIE64856.2025.11158220.

[8] A. M. Al-Zahrani and T. M. Alasmari, "Exploring the impact of artificial intelligence on higher education: The dynamics of ethical, social, and educational implications," *Humanit. Soc. Sci. Commun.*, vol. 11, no. 1, p. 912, Jul. 2024, doi: 10.1057/s41599-024-03432-4.

[9] M. Bond *et al.*, "A meta systematic review of artificial intelligence in higher education: a call for increased ethics, collaboration, and rigour," *Int. J. Educ. Technol. High. Educ.*, vol. 21, no. 1, p. 4, Jan. 2024, doi: 10.1186/s41239-023-00436-z.

[10] H. Buyones-Gonzalez and M. Quezada-Espinoza, "Artificial Intelligence in the Construction Industry: A Competency-Based Examination Through Expert Lens," in *2024 ASEE Annual Conference & Exposition Proceedings*, Portland, Oregon: ASEE Conferences, Jun. 2024, p. 46598. doi: 10.18260/1-2--46598.

[11] U.S. Department of Education (Office of Educational Technology), "Artificial Intelligence and the Future of Teaching and Learning: Insights and Recommendations," Department of Education, Washington, D.C., 2023.

[12] M. Khalil and E. Er, "Will ChatGPT Get You Caught? Rethinking of Plagiarism Detection," in *Learning and Collaboration Technologies*, P. Zaphiris and A. Ioannou, Eds., Cham: Springer Nature Switzerland, 2023, pp. 475–487. doi: 10.1007/978-3-031-34411-4_32.

[13] B. D. Lund, T. H. Lee, N. R. Mannuru, and N. Arutla, "AI and Academic Integrity: Exploring Student Perceptions and Implications for Higher Education," *J. Acad. Ethics*, vol. 23, no. 3, pp. 1545–1565, Sep. 2025, doi: 10.1007/s10805-025-09613-3.

[14] T. Rasul *et al.*, "The role of ChatGPT in higher education: Benefits, challenges, and future research directions," *J. Appl. Learn. Teach.*, vol. 6, no. 1, pp. 41–56, May 2023, doi: 10.37074/jalt.2023.6.1.29.

[15] J. Dempere, K. Modugu, A. Hesham, and L. K. Ramasamy, "The impact of ChatGPT on higher education," *Front. Educ.*, vol. 8, Sep. 2023, doi: 10.3389/feduc.2023.1206936.

[16] J. Kim, S. Yu, R. Detrick, and N. Li, "Exploring students' perspectives on Generative AI-assisted academic writing," *Educ. Inf. Technol.*, vol. 30, no. 1, pp. 1265–1300, Jan. 2025, doi: 10.1007/s10639-024-12878-7.

[17] L. Ding, T. Li, S. Jiang, and A. Gapud, "Students' perceptions of using ChatGPT in a physics class as a virtual tutor," *Int. J. Educ. Technol. High. Educ.*, vol. 20, no. 1, p. 63, Dec. 2023, doi: 10.1186/s41239-023-00434-1.

[18] R. T. Williams, "The ethical implications of using generative chatbots in higher education," *Front. Educ.*, vol. 8, Jan. 2024, doi: 10.3389/feduc.2023.1331607.

[19] O. E. H. Elmahdi, A. A. S. Balla, A. H. Abdelrady, E. Osman, and A. O. A. Ahmed, "AI-Driven Vocabulary Acquisition in EFL Higher Education: Interdisciplinary Insights into Technological Innovation, Ethical Challenges, and Equitable Access," *Forum Linguist. Stud.*, vol. 7, no. 4, 2025, doi: 10.30564/fls.v7i4.8760.

[20] G. Nieddu, B. Glushica, M. Kamilovski, S. M. Pagliara, M. C. Carrisi, and B. Gerazov, "The Role of AI in Supporting Mathematical Reasoning for Electronics Problems," in *2025 32nd International Conference on Systems, Signals and Image Processing (IWSSIP)*, Jun. 2025, pp. 1–4. doi: 10.1109/IWSSIP66997.2025.11151899.

[21] S. Tlais, A. Alkhatib, R. Hamdan, H. HajjHussein, K. Hallal, and W. E. Malti, "Artificial Intelligence in Higher Education: Early Perspectives from Lebanese STEM Faculty," *TechTrends*, vol. 69, no. 3, pp. 598–606, May 2025, doi: 10.1007/s11528-025-01061-5.
[22] F. Kamoun, W. E. Ayeb, I. Jabri, S. Sifi, and F. Iqbal, "Exploring Students' and Faculty's Knowledge, Attitudes, and Perceptions Towards ChatGPT: A Cross-Sectional Empirical Study," *J. Inf. Technol. Educ. Res.*, vol. 23, p. 004, Feb. 2024.
[23] N. Abdallah, R. Katmah, K. Khalaf, and H. F. Jelinek, "Systematic review of ChatGPT in higher education: Navigating impact on learning, wellbeing, and collaboration," *Soc. Sci. Humanit. Open*, vol. 12, p. 101866, Jan. 2025, doi: 10.1016/j.ssaho.2025.101866.
[24] A. Bozkurt *et al.*, "The Manifesto for Teaching and Learning in a Time of Generative AI: A Critical Collective Stance to Better Navigate the Future," *Open Prax.*, vol. 16, no. 4, pp. 487–513, Nov. 2024, doi: 10.55982/openpraxis.16.4.777.
[25] O. Iatrellis, I. Kosmopoulou, N. Samaras, and K. Kokkinos, "Educators' Adoption and Perceptions of Generative AI Tools in Higher Education," in *2025 6th International Conference of the Portuguese Society for Engineering Education (CISPEE)*, Jul. 2025, pp. 1–7. doi: 10.1109/CISPEE64787.2025.11124027.
[26] C. Zhang, S. Zhu, X. Yang, Y.-C. Tseng, S. Jiang, and J. M. Rzeszotarski, "Navigating the Fog: How University Students Recalibrate Sensemaking Practices to Address Plausible Falsehoods in LLM Outputs," in *Proceedings of the 7th ACM Conference on Conversational User Interfaces*, in CUI '25. New York, NY, USA: Association for Computing Machinery, Jul. 2025, pp. 1–15. doi: 10.1145/3719160.3736618.
[27] U. A. Bukar, Md. S. Sayeed, S. Fatimah Abdul Razak, S. Yogarayan, and R. Sneesl, "Decision-Making Framework for the Utilization of Generative Artificial Intelligence in Education: A Case Study of ChatGPT," *IEEE Access*, vol. 12, pp. 95368–95389, 2024, doi: 10.1109/ACCESS.2024.3425172.
[28] O. M. Schei, A. Møgelvang, and K. Ludvigsen, "Perceptions and Use of AI Chatbots among Students in Higher Education: A Scoping Review of Empirical Studies. - EBSCO," *Educ. Sci.*, vol. 14, no. 922, 2024, doi: 10.3390/ educsci14080922.
[29] Y. Almoslamani, "Factors Affecting AI-Innovation Adoption in a Higher Education Institution's Learning Management System," *Int. J. Technol. Learn.*, vol. 32, no. 2, pp. 101–116, 2025, doi: 10.18848/2327-0144/CGP/v32i02/101-116.
[30] G. Tovmasyan, "Higher education in Armenia adopting AI and digital technologies: Students' experiences and perspectives," *Issues Educ. Res.*, vol. 35, no. 2, pp. 798–817, Jul. 2025.
[31] D. Mariyono and A. N. A. Hidayatullah, "Navigating the Moral Maze: Ethical Challenges and Opportunities of Generative Chatbots in Global Higher Education," *Appl. Comput. Intell. Soft Comput.*, vol. 2025, May 2025, doi: 10.1155/acis/8584141.
[32] A. W. F. Kouam and R. M. Muchowe, "Assessing the role of AI technology in mitigating the equity gap in educational access in Zimbabwe: Barriers and implications," *J. Appl. Learn. Teach.*, vol. 8, no. 1, pp. 154–163, Jan. 2025, doi: 10.37074/jalt.2025.8.1.15.
[33] N. Kazoun, A. Kokkinaki, and C. Chedrawi, "AI Chatbots for Sustainability in Education: The Case of the Lebanese Higher Education Sector," in *Information Systems*, vol. 535, M. Themistocleous, N. Bakas, G. Kokosalakis, and M. Papadaki, Eds., in Lecture Notes in Business Information Processing, vol. 535. , Cham: Springer Nature Switzerland, 2025, pp. 19–32. doi: 10.1007/978-3-031-81322-1_2.

[34] M. Wang, “Online Collaboration and Offline Interaction between Students Using Asynchronous Tools in Blended Learning,” *Australas. J. Educ. Technol.*, vol. 26, no. 6, pp. 830–846, Jan. 2010.