

## Impact of AI-augmented pedagogy on education quality at Hail University



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### ABSTRACT

The integration of artificial intelligence (AI) in education is still in its early stages, and the gradual transformation of pedagogical practices has contributed to improvements in education quality. However, there is a lack of empirical studies investigating the impact of AI on education quality. In addition, there is a lack of a validated and reliable scale to measure AI-augmented pedagogy and its effect on education quality. This study addresses this gap in the literature by proposing a validated and reliable scale for AI-augmented pedagogy, which was tested using Confirmatory Factor Analysis (CFA). Therefore, the aim of this study is to examine the effect of AI-augmented pedagogy on education quality at Hail University. A cross-sectional questionnaire was used to collect data from 342 respondents at Hail University, and Structural Equation Modeling (SEM) was employed to examine how the key components of AI-based curricula, AI-based distance learning, and AI-based learning and engagement affect education quality. The results revealed that AI-based curricula have the strongest positive effect on education quality, followed by AI-based distance learning and AI-based learning engagement. The study also provides important practical implications for educational institutions by highlighting the importance of integrating AI tools into curriculum development and online learning environments to enhance education quality. Furthermore, the study discusses its limitations and provides directions for future research.

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## 1. Introduction

The education process faced huge transformations after the COVID-19 pandemic, where many educational institutions found themselves forced to transform the education process in the classroom to an online electronic style (Beirat et al., 2025). This increased the demand for technology and knowledge in education to solve and enhance teacher-student connection (Alghamdi and Alashban, 2023). This quick shift has accelerated the adoption of modern learning methods, unleashing more educational innovation worldwide.

Universities and schools have begun to adopt more flexible teaching methods that combine virtual and in-person learning to meet the demands of the times (Farhan et al., 2024). This is what prompted developed countries such as Saudi Arabia to make significant investments in AI, especially in the field of education.

Education has been reshaped since the integration of Artificial Intelligence Technique (AIT) in many areas of education, such as teaching, curriculum design and development, students' assessment, data analysis, and lessons planning and management (Alenezi et al., 2023; Alammari et al., 2024). Through an intelligent tutorial system, AIT supports teachers to track each student's learning needs, create assessments, progress, provide fast feedback, and analyze the data to suggest effective teaching strategies, and automate various areas of the learning process (Chen et al., 2020; Davis et al., 2024; Alammari et al., 2024). It helps teachers to find effective educational strategies based on student

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needs and learning data; these may greatly improve learning efficiency and utilize the time of teachers and students in ways that are more beneficial to the educational process (Alammari et al., 2024; Beirat et al., 2025).

Despite the Saudi government's interest in artificial intelligence (AI), its significant investments within Vision 2030 have made considerable efforts to achieve sustainable national development goals, and its determination to implement AI across all sectors, including education (Alshammari et al., 2025). Therefore, the implementation of AI in the Saudi public sector is still in its early stages. Researchers pay less attention to the AI outcomes. A very few studies have investigated the effect of AI on specific areas, such as the effect of adapting AI on the quality of financial reports (Alhazmi et al., 2025), knowledge, awareness, attitudes, and perceptions of radiologists and employees in the healthcare centers (Alghamdi and Alashban, 2023). Therefore, there is a lack of research on the outcomes of implementing AI in the education sector in Saudi Arabia.

Additionally, AI plays an important role in improving the modern education process (Chen et al., 2020; Farhan et al., 2024; Davis et al., 2024; Beirat et al., 2025). Nevertheless, has not been used as a tool to find solutions for the issues in the sociocultural educational context at universities in Saudi Arabia (Alammari et al., 2024). Where educational institutions are confronted by a complex combination of such problems as marked student proficiency diversity, inadequate teaching resources, and the demand for personal, adaptive learning setups (Alenezi et al., 2023). Hail is in the process of transition, and is facing a challenge to take full advantage of this improvement of the educational technology, which includes the rapidly growing number of international educational systems that adopt AI as a high-precision tool for learning outcome prediction, the building of personalized learning tracks, to solve many issues in student learning, and the decrease in time and administrative costs. But until now, there is a lack of empirical research that confirms the benefit of using AI as a solution tool for all previous issues in the education sector in Saudi Arabia. Specifically, there is a lack of research focusing on the impact of AI-based curriculum development on the education quality in higher education institutions in Saudi Arabia (Alotaibi and Alshehri, 2023).

Furthermore, other studies tend to investigate educators' perception of AI in education (Alammari et al., 2024), while educators considered as backstage of education quality do not make sense to evaluate the education quality because they are providers, not recipients of the education service. While investigating education quality by front stage (students' receipt of education service) makes more sense (Babakus et al., 2003). Thus, there is a lack of studies conducted on the effect of AI-based distance learning and AI-based learning and engagement on education quality, to provide a better understanding.

In addition, there is a lack of a valid and reliable scale for measuring AI-based pedagogy. Although the implementation of artificial intelligence (AI) in education has gained increasing attention, research in this area is still at an early stage. Most existing studies have focused on conceptual discussions of AI in education (Ajani et al., 2024), systematic reviews, or the realities, challenges, and barriers associated with AI adoption (Alenezi et al., 2023; Alotaibi and Alshehri, 2023; Amin et al., 2025). Only a limited number of empirical studies have examined the practical implementation of AI in education, particularly its impact on educational quality (Alammari et al., 2024; Farhan et al., 2024; Nkolika, 2025).

Furthermore, these studies have not employed advanced statistical techniques, such as Confirmatory Factor Analysis (CFA), to validate the measurement scales used for assessing AI-based pedagogy. Therefore, there is a critical need to develop a valid and reliable measurement scale for AI-based pedagogy and to evaluate it using rigorous statistical methods. To address these gaps, the present study develops and validates a measure of AI-enhanced pedagogy in higher education and examines the effects of AI-based curriculum development and students' perceptions of AI-enhanced pedagogy on educational service quality in higher education institutions in Saudi Arabia.

## 2. Literature review

Artificial intelligence (AI) in education has transformed pedagogical strategies more by providing previously unheard-of chances for individualized instruction, effective resource management, and improved academic achievement. This AI-enabled pedagogy is the first of its kind in Hail, Saudi Arabia, where educational entities take the primary role in the innovation and excellence in implementing the Vision 2030 (Alshammari et al., 2024). To get an insight into how the mentioned techniques may apply to the causes of educational quality in Hail, this literature review draws on the empirical evidence for AI in education, the optimized use of resources, and the joint efforts of students. AI has several applications in education, such as predictive analytics, automated grading, smart tutors, and adaptive learning systems (Luckin and Cukurova, 2019). Artificial intelligence (AI)-infused tools, like the ones that employ machine learning and natural language processing, personalize and consequently make up for the missing knowledge immediately (Chen et al., 2020). In research from Popenici and Kerr (2017), chatbots, virtual tutors, and gamified modules are some of the strategies used by AI to make the engagement of students more interactive through immersive and interactive learning.

The research carried out in Saudi Arabia underscores the importance of distributing resources equitably to shrink the educational

disparities between the urban and rural areas (Alshahrani and Mostafa, 2025).

In escalating the occurrence of AI-driven optimization model development, other GCC states have been able to achieve institutional efficiency. Hail could minimize overcrowding, ensure teacher-quality deployment, and rate cost-effective technology integration through AI in resource management. Moreover, it is shown by a piece of statistical evidence that academic performance has been significantly improved thanks to AI-supported learning and the judicious use of resources. According to an aggregate analysis of 230 research studies on raising grades. Kulik and Fletcher (2016) stated that AI-based adaptive learning leads to 15%-25% higher grades in students. In the same vein, schools that deploy AI in resource allocation and systematic quality assurance increase student retention and satisfaction (Agasisti et al., 2019). Pilot initiatives introducing AI into STEM education within the Middle East demonstrate clear benefits for student development of critical thinking and problem-solving (Alhashmi et al., 2020).

Another study conducted by Beirat et al. (2025) focused on the effect of teachers' feelings of emotional exhaustion and, consequently, the risk of burnout. The study indicated a low degree of efficiency in using AI, while there was a higher degree in using technology in general. The result indicated the possibility of using AI in computerizing students' assessment and problem solving, which in turn contributes to enhancing the education quality. A study by Davis et al. (2024) revealed that AI can be a key tool in developing a more flexible, effective, and inclusive learning environment, making the educational environment more open and diverse, motivating students, enhancing their learning abilities, and creating a rich and equitable educational experience.

Regarding literature in the higher education context, previous studies indicated that applied AI had a significant effect on education quality. For instance, Farhan et al.'s (2024) study indicated that the use of AI technology has a significant impact on the quality of educational services at the University of Baghdad. The study revealed that AI-enhanced classrooms can provide a unique learning experience and a developed and stimulating learning environment. Furthermore, it can effectively address student problems and complaints through technological means and communication platforms. A study by Nkolika (2025) revealed that using AI in curriculum development has many advantages, including enhancing students' personalized learning experiences, improving curriculum quality, and increasing teaching efficiency. However, the application of AI faces several challenges, such as the high cost of technical equipment, limited access to high-quality learning materials, a lack of technical expertise among instructors, and their resistance to change.

In the Hail University context, a study conducted by Singh (2026) focused on the most significant

factors that improve the students' engagement and academic excellence by AI and digital learning from the Hail University students' perspective. The study found that perceived usefulness and ease of use of AI tools, availability and accessibility to AI tools, and AI-based personalization have a positive effect on academic excellence, and digital learning moderates AI-driven factors and students' engagement and academic excellence. Another study by Thomran et al. (2025) revealed that revealed psychological limitations that students may face when using advanced technology such as AI. To mitigate these limitations, the study indicated that educational institutions should develop strategic plans to enhance the IT skills of both students and faculty, thereby maximizing the use of technology, including AI, in improving the educational process.

In this way, Hail University may be equipped to promote Saudi Arabia's National Transformation Program and develop a future-ready, competitive workforce using similar methods. The quality of education in Hail University can be directly enhanced through the combination of AI-enhanced pedagogy with effective allocation strategies. Although recent studies demonstrate the potential for AI leverage in terms of efficiency and personalized learning, ethical, cultural, and infrastructural barriers must be overcome to advance deployment. Future work will need to examine localized AI models designed for Hail's unique educational context to provide equitable and sustainable impacts for learning and student achievement. Therefore, the current study assumed that developing AI-Augmented pedagogy has a positive and significant effect on education quality in Hail University.

There is a big concern regarding the need for more thoughtful and equitable AI design and implementation, particularly to prevent educational gaps or pedagogical integrity (Garzón et al., 2025). All learning methods must make decisions regarding what they teach (i.e., curriculum). Academics' autonomy has enabled higher education systems to make decisions based on their contribution to research outputs within their disciplines. AI could act as a virtual curriculum assistant to address students' time-consuming and repetitive queries about curriculum (Liang et al., 2025). Two research studies have investigated the perception of how academic is shaped by the use of AI on specific subject-related curricula and teaching, one in data science and one in English translation (Chen et al., 2023; Wang, 2024). For example, Sajja et al. (2023) used the curriculum and other teaching materials to design a curriculum-oriented intelligent assistant and discovered that this virtual teaching assistance provided perfect course information and improved students' course engagement effectively.

According to Alshaie et al. (2025), pedagogical and technical training in using AI, the infrastructure may not be suitable for employing AI tools, and the students' lack of motivation collectively dampens the impact of otherwise high AI competence. With AI, the

quality of education is positively and dramatically impactful since it will allow more personalized, adaptive, and engaging learning. Indicatively, research claims that AI-based curriculum tools enhance student engagement and understanding by providing meaningfully and sufficiently challenging learning content, besides providing real-time feedback, enhancing the learning process (Sajja et al., 2023).

On the same note, more extensive systematic reviews underline that the incorporation of AI in curriculum design positively influences the learning outcomes, the student motivation, as well as equitable access to high-quality instructional resources, which undoubtedly improves the quality of education in general (Garzón et al., 2025). Therefore, the following hypotheses have been formulated.

**H<sub>01</sub>:** AI-based curricula have no effect on educational quality.

**H<sub>02</sub>:** AI-based distance learning has no effect on educational quality.

**H<sub>03</sub>:** AI-based learning and engagement tools have no effect on educational quality.

The hypotheses include three independent variables: AI-based curricula, AI-based distance learning, and AI-based learning and engagement tools, where each of these is a variant of artificial intelligence implementation in education. These variables are laid as possible effects on the dependent variable, which is the quality of education.

### 3. Methodology

The study used the quantitative research method to empirically examine the effect of AI-augmented pedagogy on education quality service in Hail University. A cross-sectional design was used to obtain data from university students at Hail University. A survey was developed in both English and Arabic languages through a comprehensive evaluation of scholarly literature to develop the measures, which have been validated through a pre-test, and following the procedure for translating the measurement, this has been done to ensure the consistency between the Arabic and English versions. The survey was sent to five professors in pedagogy development and specialists in education technology and AI to evaluate the content validity of the survey. They reviewed the survey and provided feedback, such as suggestions for revising some items and improving item wording. The experts' comments and suggestions have been considered and amended, which helps to enhance the validity and content of the survey. Furthermore, the survey underwent a pilot stage with a sample of 35 students before the final distribution to ensure validity and reliability. The implementation of the above activities has contributed to improving the survey and ensuring its clarity and comprehensiveness, and

suitability to the university context, while providing a deeper understanding of the characteristics of education and the university environment (Birtch et al., 2016). The survey subsequently underwent review and was approved by the Scientific Research Ethical Approval Committee (SREAC) at the University of Hail. The survey was conducted via an online platform and used for data collection. The respondents were invited to participate through electronic channels with a particular focus on WhatsApp. Personalized invitations with written consent were carefully distributed and sent to each participant, including the study objectives and confidentiality measures to ensure that respondents fully understood their participation was voluntary. These procedures help to increase the response rate.

#### 3.1. Participants

The survey included students currently enrolled at Hail University. To conduct a comprehensive investigation and evaluation of the results, students were chosen as a sample for this study to provide their perception of performance education service, as they are the recipients of the education service (Babakus et al., 2003), and provide a better understanding of the education service using AI. Therefore, the sample of the study contains 343 students who completed the survey.

#### 3.2. Instruments

The questionnaire was used to collect the data from the respondents. It contains two parts: the first part is used to ask the respondents for their demographic information (e.g., gender, level of study, and their facilities). This is to provide information about the university's application of AI in each faculty (e.g., scientific faculties, health faculties, and humanities faculties), and this information provides more understanding about using AI in these faculties. The second part had two sections; the first section contained the measurement of AI-augmented pedagogy, which had three dimensions: AI-based curricula development, which was measured by seven items; AI-based open distance learning (ODL), and measured by four items; and AI-based enhanced learning engagement measured by four items; these scales were adapted from Farhan et al. (2024) and Nkolika (2025). The second section contains measures of student perception about performance education quality, by adapting twelve Likert items to address four dimensions of performance education service. These items are adapted from previous studies that measured education service in universities (Yousapronpaiboon, 2014).

#### 3.3. Data analysis

The data obtained from the respondents was analyzed through two phases; the initial stage was

done by using SPSS for descriptive statistics (e.g., respondents' profiles, means, standard deviation, normality, and multicollinearity for the variables). The second stage is conducted using structural equation modeling (SEM) by using AMOS. In this stage, CFA has been done to ensure the measures are valid and appropriate for the advised analysis, followed by conducting SEM-based testing of the direct hypothesis.

**4. Results**

**4.1. Demographic profile of the respondents**

The descriptive statistics were applied for the participants' profiles to provide an overview of the relative information requested from the respondents in the survey instrument regarding their demographic profiles. Table 1 shows the results of the descriptive statistics of the participants' demographic profiles. The sample of the study contains 343 students who completed the survey, of whom 215 (62.7%) were male, while female was 128 (37.3%). Most of them were in level one 112 (32.6%), followed by level two students 96 (28%), and then level three 85 (24.8), finally level four 50 (14.6%). The students were distributed in three fields of study: scientific, health, and humanities. Most of them, 149 (43.4%), were from health colleges, while 101 (29.5%) were from Humanities colleges, and lastly, 93 (27.1%) were from scientific colleges.

**4.2. Descriptive statistics, normality, and multicollinearity for the variables**

Descriptive statistics shown in Table 2 highlighted the means of respondents and standard deviations, normal distribution, multicollinearity, and correlations between the study's variables. The results showed that all variables of this study were correlated positively, as was expected. All correlations between the variables were not 0.80. This set of data was distributed normally, as shown by the values of skewness and kurtosis under the cutoff value as recommended by scholars and

researchers (Hair et al., 2010), and the values were in the range for skewness between (-0.621 to 0.162) and for kurtosis between (-0.313 to 0.280), while the variance inflation factor (VIF) was applied to evaluate multicollinearity for the independent variables, and it was in the range of values, as values between 1.019 to 1.324. This result confirmed that the model is free of any issues due to the VIF values being below the cutoff of 10. Table 2 shows the results of descriptive statistics, normality, and multicollinearity.

**Table 1:** Participants' demographic profiles

Characteristics	Category	N	Percentage
Gender	Male	215	62.7
	Female	128	37.3
	Level one	112	32.6
Level of study	Level two	96	28
	Level three	85	24.8
	Level four	50	14.6
	Health colleges	149	43.4
Field of study	Scientific colleges	93	27.1
	Humanities colleges	101	29.5

**4.3. Assessing the measurement model**

Two measurement models of AI-augmented pedagogy and education quality, comprising 27 observation variables and distributed on seven dimensions, were proposed and tested to evaluate the hypothesis of the study. The result of all factors loading exceeds the cut-score of the value of 0.50. The result of the CFA for the proposed model revealed that the fit indexes of the model were adequate, as the statistics of X<sup>2</sup> were 573.307, DF was 314, CMINDF was 1.826, and p < 0.000, and CFI = 0.952, TLI = 0.947, IFI = 0.953, and RMSEA = 0.049, all of which were shown adequate fit indices (Kline, 2023). The constructs' reliability in this model was tested by using composite reliability (CR). The factor loading for all the items was higher than 0.70; all loading values for AI-augmented pedagogy and education quality ranged between 0.70 and 0.88, and 0.71 to 0.86, respectively. Average variance extracted (AVE) values were >0.50. The result for all indicators showed acceptable values for reliability and convergent validity of the study model (Table 3).

**Table 2:** Descriptive statistics, normality, and multicollinearity

Variables	Mean	SD	Skewness	Kurtosis	VIF	AI-Cur	AL-DL	AI-LEG	EQ
AI-based curricula (AI-Cur)	3.11	.843	-.203	-.313	1.324	-	-	-	-
AI-based ODL (AI-DL)	3.47	.650	-.621	.280	1.109	.313**	-	-	-
AI-learning engagement (AI-LEG)	3.00	.871	.162	-.498	1.218	.423**	.137*	-	-
Education services (EQ)	3.32	.753	-.548	.068	-	.535**	.340**	.388**	-

\*\* : p < 0.01

Furthermore, discriminant validity was assessed through two approaches: Fornell-Larcker criterion and HTMT, as recombined by previous studies. The Fornell-Larcker criterion approach was through the square root of AVE, as suggested by Fornell and Larcker (1981), and HTMT through the correlation between all constructs that should be less than 0.85, as suggested by Henseler et al. (2015). The results of the Fornell-Larcker criterion and HTMT showed

discriminant validity indexes for all constructs were educated, and Panel A in Table 4 displays the result of the Fornell-Larcker criterion, and Panel B displays the HTMT result.

Meanwhile, the results of the hypothesis tested are shown in Table 5. These contain the value of beta reflecting the effect of AI-augmented pedagogy (AI-based Curricula, distance learning, and learning engagement) on education quality. The beta values

indicate the positive effect, while t-statistics and p-values measured the significant effect of AI-based curricula, AI-based distance learning, and AI-based learning engagement on education quality. Therefore, the standardized path coefficients of the structural model showed the significant positive effects of AI-based curricula on education quality (B = 0.37, t = 6.06, p = 0.000), AI-based distance

learning (B = 0.27, t = 3.85, p = 0.000), and AI-based learning engagement (B = 0.19, t = 3.39, p = 0.000). The t-statistic values for each path were higher than the cut score of 1.96, with a p-value of < 0.05, which indicated that all the direct effects of AI-augmented pedagogy were significant, as suggested by Byrne (2016). Therefore, all the alternative hypotheses have been accepted.

**Table 3:** Factor Loading indicator, reliability, and validity for all constructs

Construct	Factors	Items	Loading	CR	AVE
AI-augmented pedagogy	AI-based curricula	AI-Cur1	0.72	0.90	0.64
		AI-Cur2	0.80		
		AI-Cur3	0.83		
		AI-Cur4	0.84		
		AI-Cur5	0.80		
		AI-Cur6	0.79		
		AI-Cur7	0.81		
	AI-distance learning	AI-DL1	0.73	0.83	0.56
		AI-DL2	0.77		
		AI-DL3	0.70		
		AI-DL4	0.78		
		AI-DL5	0.78		
AI-learning engagement	AI-LEG1	0.82	0.88	0.64	
	AI-LEG2	0.74			
	AI-LEG3	0.75			
	AI-LEG4	0.88			
Education quality	Education quality	EQ1	0.85	0.97	0.62
		EQ2	0.71		
		EQ3	0.80		
		EQ4	0.74		
		EQ5	0.77		
		EQ6	0.83		
		EQ7	0.86		
		EQ8	0.82		
		EQ9	0.77		
		EQ10	0.84		
		EQ11	0.89		
		EQ12	0.81		

**Table 4:** Discriminant validity using Fornell–Larcker criterion and HTMT

Construct	Panel A: Fornell and Larcker criterion				Panel B: HTMT			
	AI-Cur	AI-DL	AI-LEG	EQ	AI-Cur	AI-DL	AI-LEG	EQ
AI-curricula	0.800				-			
AI-distance learning	0.313**	0.750			0.380	-		
AI-learning engagement	0.423**	0.423**	0.800		0.470	0.180	-	
Education quality	0.535**	0.535**	0.388**	0.790	0.590	0.430	0.410	-

\*\* : p < 0.01

**Table 5:** Hypothesis result: “Standardized regression estimation” of direct effects

Path	Estimate		SE	t-value	p-value	Results
	Unstandardized	Standardized				
AI-Cur →EQ	0.370	0.410	0.061	6.060	0.000	Supported
AI-DL →EQ	0.271	0.230	0.071	3.850	0.000	Supported
AI-LEG →EQ	0.190	0.200	0.055	3.390	0.000	Supported

EQ: Education quality; AI-DL: AI-based distance learning; AI-LEG: AI-Based enhanced learning engagement

### 5. Discussion

This study examined a structural model that tested the effect of AI-augmented pedagogy on education quality in higher education institutions in Saudi Arabia. The empirical results reveal that AI-augmented pedagogy, through its three components (AI-based curricula, AI-based distance learning, and AI-based learning engagement), has a positive effect on education quality at the University of Hail. These outcomes mean that using AI in education to develop curricula, distance learning, and learning engagement positively improve education quality. With this mechanism, it’s going to provide them with recent pedagogy techniques that meet their current needs and keep pace with development in education technology, including the integration of AI into the

education process. The result highlighted that the AI curricula have the greatest impact on the quality of education. This means that employing AI technologies in curriculum development through content creation, course organization, and delivery significantly contributes to enhancing the quality of education provided by the university.

The results revealed that curricula developed by AI have a positive effect on education quality. This result means that curricula developed by AI provide students with flexible learning methods, which enable them to study at a suitable time, meet each student’s personal and cognitive capabilities, and respect the students’ differences in the best ways for them to learn. Furthermore, it provided more flexibility to ensure proper provision of the content to meet the students’ needs and enable lecturers

with more autonomy to design their lectures and lead and encourage each student to learn in the best way, and enhance their learning experience. Through this dynamic, it can improve education quality. These observations are consistent with the previous argument provided by [Farhan et al. \(2024\)](#), [Davis et al. \(2024\)](#), and [Nkolika \(2025\)](#).

Furthermore, the current result revealed that AI-based distance learning has a positive effect on education quality. This finding means that when students use AI to support their online and distance learning (synchronous or asynchronous) the education quality is improving. When universities provide students with online resources, virtual classrooms during difficult times (e.g., COVID-19), and have a smart assessment system and platform, they facilitate and provide learning anytime and anywhere, which enhances education quality ([Ramírez-Hurtado et al., 2021](#)).

Additionally, the impact of AI-based distance learning on the quality of the provided education is substantial, and it is beneficial because it increases the accessibility rate, personalization, and flexibility of the instruction, which are not achievable through traditional online learning. Research demonstrates that AI-based online platforms applied in distance learning create equal access to knowledge, promote personalized learning experiences, and enhance pedagogical flexibility, all of which enhance the overall quality of teaching and learning ([Morgado et al., 2025](#)). All these findings point to the fact that AI-enhanced distance learning is very useful in improving the quality of education by rendering the learning process more adaptive, efficient, and responsive to the needs of different types of learners. These explanations are consistent with the previous researchers who argued that integrated AI in the education process provides students with a more effective and personalized and enhances interaction between students and their lecture which improves education quality ([Farhan et al., 2024](#); [Amin et al., 2025](#)). This result is in line with the findings of [Morgado et al. \(2025\)](#), who highlighted the transformative potential of AI and digital platforms in distance education.

The findings have indicated that there is a positive effect of AI-based enhanced learning engagement on education quality in higher education. This link is further supported by the current study, which provided empirical evidence on the effect of learning engagement through AI on education quality in Hail University. With AI, the quality of education is positively and dramatically impactful since it will allow more personalized, adaptive, and engaging learning ([Garzón et al., 2025](#)). This means that AI provides student learning and engagement motives to be active learners, interactive, and makes the education process more effective, and improves education quality. This outcome is consistent with previous studies that revealed that AI-based learning and engagement motivated students and learning performance, which led to improved education quality ([Alenezi, 2023](#);

[Zhang and Miao, 2025](#)). Student engagement through AI tools enhanced the interaction and feedback between students and staff and improved education quality. This is aligned with [Ajani et al. \(2024\)](#), who argued that AI-based learning and engagement not only enhances efficiency in saving time, but it also promotes providing timely feedback to students, which facilitates and supports their educational journey and improves the quality of education. The use of AI-based learning and engagement tools has a positive impact on the quality of education as it enhances motivation, engagement, and learning among students ([Mohamed et al., 2025](#)).

Systematic reviews also prove that AI-powered learning tools enhance student engagement and simplify the learning processes, resulting in better academic performance and a more efficient learning environment in general. The results mean that AI-powered engagement tools are able to improve the quality of education, providing more interactive, responsive, and student-centered learning ([Younas et al., 2025](#)).

The results of this study revealed that AI-augmented pedagogy has a positive and significant effect on education quality at Hail University. This result has a practical contribution by highlighting the effect of integrated AI in pedagogy to improve education quality, through focusing on three aspects of pedagogy: curricula, distance learning, and learning engagement. Therefore, this result proved practical implications for universities to develop their curricula more dynamically, personalized to students' needs, learning styles, and performance outcomes, which will strengthen their perception of the educational process as more suitable and responsive to their needs, which positively impacts the perceived quality of education ([Ramírez-Hurtado et al., 2021](#)). This finding emphasizes the necessity for universities to arrange for the integration of AI, particularly intelligent analytics tools, into curriculum development ([Diwan et al., 2023](#)) and transform the traditional curricula to be more flexible, so that they positively respond to student learning data, which is crucial for raising the perceived quality of education.

These results emphasize that more investment by the universities is required to develop their infrastructure for curriculum tools design through matching the students' needs, AI awareness, and upskilling academic staff to integrate AI into course planning and ensuring curriculum frameworks support adaptive and personalized learning pathways. It also confirms that there is a need for improving distance learning and the development of smart learning platforms and advanced systems for assessing students' performance, and digital libraries supported by algorithms to suggest appropriate scientific content, which contributes to improving the quality of education ([Amin et al., 2025](#)). Furthermore, these results recommend that universities adopt and develop AI tools that enhance student learning and engagement through interaction, participation, and feedback. Universities

should integrate these technologies within a framework that is fully complemented by AI-enhanced curricula and distance learning platforms. This will lead to an improvement in the quality of the educational process.

## 6. Conclusion

This study aims to examine the effect of AI-augmented pedagogy, which is conceptualized by three dimensions (AI-based curricula, AI-based distance learning, and AI-based learning and engagement), on education quality at Hail University. The new scale of AI-augmented pedagogy has been proposed and assessed by CFA and has obtained high validity and reliability. The result of the study revealed that AI-augmented pedagogy has a positive and significant effect on education quality. Specific AI-based curricula had the greatest impact on improving students' perceptions of the quality of education, followed by distance learning and learning engagement.

The result indicated that investment in AI-based curricula, distance learning, and learning and engagement can be a key factor to improve education quality and enhance the education experience from the student's perspective. Furthermore, the role of AI in the education process not only provides a distance learning environment, but it also supports student interaction and engagement in the education process. Additionally, universities should invest in AI as a strategic tool that reforms the method of redesigning the curricula and teaching methods and managing the education process more adapted to students' needs and expectations. Two factors limit this study: first is the participants and sample of respondents (N= 342), students were selected from a single university in Saudi Arabia, which makes it hard to generalize to the entire higher education sector. Therefore, more studies are needed to include other universities before generalizing these results. Furthermore, since the research is limited to evaluating the quality of education and AI-augmented pedagogy as they have emerged in higher education, the results should not be used to evaluate the quality in other levels of education, due to the nature of differences. Future research may conduct and consider various antecedents and consequences of AI-augmented pedagogy, such as management commitment and investment in AI technology, the lecturer's perspective of AI-augmented pedagogy, and students' attitudes toward using AI platforms and systems. Therefore, there is a belief that the methods and the structural model of this study may be replicated or including other antecedents or consequences in other settings and contexts.

## List of abbreviations

AI	Artificial intelligence
AI-Cur	AI-based curricula
AI-DL	AI-based distance learning

AI-LEG	AI-based enhanced learning engagement
AIT	Artificial Intelligence Technique
AL-DL	AI-based distance learning
AVE	Average variance extracted
B	Standardized regression coefficient (beta)
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CMINDF	Chi-square divided by degrees of freedom
CR	Composite reliability
DF	Degrees of freedom
EQ	Education quality
GCC	Gulf Cooperation Council
HTMT	Heterotrait-Monotrait ratio
IFI	Incremental fit index
N	Number of respondents (sample size)
ODL	Open distance learning
RMSEA	Root mean square error of approximation
SD	Standard deviation
SE	Standard error
SEM	Structural equation modeling
SREAC	Scientific Research Ethical Approval Committee
STEM	Science, technology, engineering, and mathematics
t	t-statistic
TLI	Tucker-Lewis index
VIF	Variance inflation factor

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## Compliance with ethical standards

## Ethical considerations

This research was conducted in strict compliance with the 1964 Helsinki Declaration and its later amendments, as well as the Scientific Research Ethical Approval Committee (SREAC) at the University of Hail, Saudi Arabia, under approval number (H-2025-347). This research was not a medical study, nor did it involve human experimentation as contained in the Declaration of Helsinki. All the respondents in the study were well above 18 years of age, and they voluntarily answered the research questionnaire. The information provided by the respondents was strictly used for this study and treated with utmost confidentiality and anonymity.

## Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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