

Impact of Sustainability Awareness on AI Perception, Engagement, and Motivation among University-Level Literature Students

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Abstract

AI is gaining recognition as a strategic tool in education, helping to reduce student workload and enhance learning. As technology rapidly evolves, institutions in the United Arab Emirates and the Kingdom of Saudi Arabia are actively integrating it into academic environments to better support students. As a result, it is crucial to examine its current impacts on students' academic journey. This research aimed to examine the effect of sustainability awareness on academic aspects of higher education students in the GCC region. In other words, the focus remained on analyzing the effects of sustainability awareness on improving learning engagement, Perceptions of AI, and Educational Motivation among English language learners in the UAE and Kingdom of Saudi Arabia. Theoretically supported by Constructivist Learning Theory, data were gathered from 171 students using a random sampling technique from the selected institutions. Results show that sustainability awareness positively affects perceptions of AI in education, implying that students perceive AI as a useful tool for improving their understanding of sustainability. The effect of sustainability awareness on learning engagement remained significant, indicating that integrating sustainability topics into coursework improves students' interest and enhances their overall engagement in learning. Finally, the effect of sustainability awareness on educational motivation was also significant. This shows that sustainability-related learning promotes academic motivation, encouraging students to aim higher academically and giving them a stronger sense of purpose in education. Thus, it is concluded that institutions can improve this awareness by embedding sustainability-focused projects, reflective activities, and interactive tools within the curriculum. This approach not only reinforces the positive impact of AI in achieving sustainable development goals but also aligns with constructivist principles, where students actively connect new knowledge to real world issues, leading to the most constructive educational outcomes.

Keywords: Sustainability Awareness, Learning Engagement, Learning Motivation, AI in education, Structural Equation Modelling

1. Introduction

The term “sustainable” is refers to as practices that can continue long-term without causing major environmental, economic, or social harm, addressing recent needs without compromising the ability of future generations to meet theirs. Sustainable education promotes a culture that values creativity, active participation, and diversity, supporting students in sustainable growth. According to Relmasira et al. (2023), expanding education for sustainable development allows students to experience transformative learning, empowering them to act as supporters. The United Nations further emphasized sustainability by introducing sustainable development goals (SDG) in 2015, targeting an end to poverty, preservation of the planet, and global prosperity and peace by 2030. However, the relevant entity highlighted education as one of the key drivers to ensure sustainable development. In this context, the United Arab Emirates and the Kingdom of Saudi Arabia are among those countries in the GCC region where sustainable development goals and their execution are successfully followed by a major transformation in the education sector (Tahiru, 2021). For example, the government of the UAE is focusing on quality education as the fourth SDG, focusing on ensuring inclusive, lifelong, and equitable learning for everyone, aiming to build sustainable competencies in students (Alotaibi & Alshehri, 2023b; Mutambik, 2024). According to the sustainable development agenda, ten specific targets detail the ways to acquire quality education, highlighting the use of modern information technology, such as intelligent tutoring systems (ITSs), to advance sustainable education. AI provides intelligent tools that adapt learning experiences to individual students by assessing factors like emotion, motivation, and cognitive ability, and their knowledge, learning preferences and skills. These systems track progress, assign tailored tasks, offer guidance, and provide student-centred approaches to attain sustainable education (Shwedeh et al., 2024).

Today, AI is increasingly recognized for its strategic role in education, with the potential to improve learning by easing the workload for both teachers and students. Combined with current educational advancements like digital resource integration, gamification, and designed learning experiences, AI offers a range of possibilities for further innovation in education (Su & Yang, 2023). Here, Elbeshti et al. (2022) cited an example of using AI models to create adaptive, responsive tutorials that build individualized learning environments, which can help address teacher shortages through smart tutoring systems. These systems support personalized learning by assigning suitable tasks and tracking student input, facilitating interaction and providing targeted feedback. Consequently, educational institutions in the UAE and the KSA prefer technology-driven solutions that are safe, adaptable, and effective on a larger scale (Ouyang & Jiao, 2021). The preceding argument is further reflected in the problem statement of this study as both UAE and KSA have widely implemented modern technology in academia. With rapid technological advancement in daily life, educational institutions are confident that these developments can meet their priorities. Just like every other organization, educational institutions are using AI tools in their everyday tasks. These include voice assistants, sentence-completion tools, grammar checkers, or automated planning applications, many institutions are exploring and integrating this technology, recognizing the potential of AI capabilities to provide students with enhanced support and learning experiences. As a result, students with learning disabilities, multilingual learners, and other groups all benefit equally from more adaptive and personalized digital learning possibilities (Tahiru, 2021). According to Shishakly et al. (2024), educational institutions in the region also motivate their teachers to explore how AI can assist them in writing and refining lessons and streamlining the process of selecting, finding, and customizing materials for their classrooms.

Thus, based on the importance of AI in education as one of the core considerations of sustainable development goals, this research aims to examine effects of sustainability awareness on students' educational experience. In other words, the primary focus of this research is to investigate how students' awareness of sustainability affects their perceptions of AI in education, learning engagement, and educational motivation in the two public sector universities in the GCC region (UAE and KSA). Focusing on English and World Literature students is particularly relevant due to the unique intersection between literature studies, sustainability education, and emerging AI technologies (Zakameh et al., 2021). Literature curricula often engage with themes such as eco-criticism and social justice, offering a critical lens to explore human relationships with the environment and society, core components of sustainability awareness. Integrating sustainability topics within literature encourages students to critically analyze texts through an ecological and ethical framework, fostering deeper reflection on global challenges. Moreover, AI tools offer practical support in literature education by enabling advanced text analysis, personalized language learning and interactive engagement with complex literary concepts (Farhi et al., 2023; Farhi, Jeljeli, Zahra, et al., 2023). These technologies can help students develop critical thinking and interpretive skills while also making sustainability themes more accessible and relevant. For example, AI-driven platforms can help students explore patterns related to environmental narratives or social issues across diverse texts, enhancing both their academic and sustainability literacy. Within the GCC context, rapid educational reforms emphasize the integration of digital innovation and sustainability to align with Vision 2030 initiatives in countries like Saudi Arabia and the UAE. These reforms advocate for curricula that prepare students to address regional and global sustainability challenges while embracing modern technologies and innovations. Therefore, focusing on English and World Literature students in this region offers timely insights into how AI and sustainability awareness can be effectively combined to enrich education, promote cultural relevance, and support national development goals.

Notably, existing literature indicates various positive, constructive aspects of AI in education from the perspective of sustainable development. However, these studies are based on a review approach (Chen et al., 2020; Tahiru, 2021; Zhai et al., 2021) or explore the relevant phenomenon from the perspective of AI in education (Ali, 2024; Alotaibi & Alshehri, 2023a; Alshammari et al., 2023), lacking the element of sustainable development awareness. This research fills the empirical gap by exploring the relevant aspects from the lens of sustainable development goals in UAE and KSA. The significance of this research can be determined by its focus on key educational outcomes among literature students. This study provides practical insights for educators and policymakers by understanding how awareness of sustainability influences students' attitudes and motivations, providing guidance for policymakers and educators aiming to integrate sustainable practices into curricula effectively. Also, exploring students' perceptions of AI within the sustainability context highlights the prospect of technology to improve educational experiences in an eco-friendly manner. The results contribute to the growing body of literature on sustainability in education, providing a framework for developing responsible, motivated, and technologically adept learners prepared to address global sustainability challenges. Thus, this research addresses the following main questions:

RQ1: How does students' awareness of sustainability influence their perceptions of AI in education?

RQ2: What is the relationship between sustainability awareness and students' learning engagement in literature courses?

RQ3: To what extent does sustainability awareness impact students' educational motivation in higher education contexts?

2. Literature Review

2.1 Constructivist Learning Theory

Expanding on the constructivist approach, this research proposes that integrating AI into education has the transformative potential to engage students more deeply in their educational journey (Dai & Ke, 2022). Constructivist philosophy holds that students learn best when they actively engage with new content, relating it to their existing knowledge and experiences. In the learning context, this involves moving beyond rote memorization to active use, interpretation, and personal connection to the language (Alarabi et al., 2023; Ibrahim Zakameh et al., 2021). AI tools, including intelligent tutoring systems and adaptive platforms, play a critical role in making this

interaction meaningful. These tools can analyze each learner's unique needs, language proficiency, and challenges, designing feedback and suggestions to facilitate a more personalized and interactive learning experience (Relmasira et al., 2023). Through these real-time learning adjustments, AI enables language learners to feel both supported and challenged, motivating them to explore, practice, and refine their English skills in a way that feels more natural and relevant to their progression (Harry & Jati, 2023). Besides, constructivist learning theory highlights the importance of scaffold support, providing guidance that responds to the learner's current abilities. AI systems excel at this by dynamically adjusting complexity, giving hints, or breaking down tasks to match a learner's developing skills. This scaffolding is consistent with Vygotsky's zone of proximal development, where learners succeed on tasks that are just within reach with the right support. AI improves this process by ensuring that students obtain feedback or assistance precisely when needed, avoiding frustration or disengagement. In this way, AI works as a powerful assistant that complements human instruction, ensuring that learners stay motivated and continue building confidence (Alshammari et al., 2023; Louati et al., 2024). According to Alismaiel et al. (2022), one benefit of AI in constructivist language education is its capability to promote metacognition, the ability of students to monitor and regulate their learning process. By motivating students to reflect on their learning, they identify areas where they need improvement and actively set goals. In this regard, AI tools enable students to take ownership of their language acquisition. This is especially significant for English learners who benefit from understanding both "how" and "why" behind language rules and structures. Therefore, it is assumed that AI as a constructivist tool can support sustainability awareness and enhances students' overall perceptions learning experience of students in both institutions.

Building on constructivist learning theory, sustainability awareness can be viewed as a critical attitude that influences how students engage with educational content and technology. Within a constructivist environment, where learners actively construct meaning, integrating sustainability awareness encourages students to relate new knowledge not only to their existing cognitive framework but also to broader ethical and ecological contexts (Sterling, 2011; Wiek et al., 2011). This consistency promotes deeper personal engagement, as students perceive learning as relevant to real-world challenges, thereby enhancing intrinsic motivation (Ryan & Deci, 2020). AI-facilitated constructivist environments provide personalized scaffolding that can dynamically incorporate sustainability-related content and values, promoting critical reflection on the societal impacts of learning (Nicol et al., 2023). By tailoring feedback to students' evolving understanding of sustainability, AI tools help learners connect academic concepts with sustainable development goals, strengthening both their cognitive and affective engagement (Kopnina, 2017). Empirical studies have linked sustainability education to increased motivation and engagement by incorporating purpose-driven learning goals and promoting a sense of responsibility towards global challenges (Markowitz et al., 2020; Ojala, 2012). Integrating these insights, the proposed model situates sustainability awareness as a mediator that enhances how constructivist-AI approaches can improve students' perceptions, engagement, and motivation, leading to a more significant and socially aware learning experience.

2.2 Sustainability Awareness and Perceptions of AI in Education

Sustainability awareness refers to students' understanding and recognition of sustainable practices, including their social, environmental, and ethical importance. It involves being aware of how actions and decisions impact long-term ecological balance, equity, and responsible use of resources, especially within the context of education and technology. This awareness influences students' attitudes toward integrating sustainability principles into their learning and impacts their perceptions, engagement, and motivation in educational settings. Sustainability Awareness and Perceptions of AI in Education are defined as the relationship between students' knowledge of sustainable practices and their opinions on AI's role in education, particularly regarding whether AI is consistent with ethical responsibility, equity, and environmental mindedness goals. Notably, AI-driven personalized learning has the potential to significantly influence educational experiences, particularly in shaping students' perceptions of technology and sustainability awareness. Adaptive learning systems powered by AI technology, dynamically adjusted curricula, and teaching approaches based on real-time assessments of students' engagement and performance (Alqahtani et al., 2022). These systems, including intelligent tutoring systems, can stimulate personalized, one-to-one instruction, improving the relevance and impact of learning. In addition to promoting effective and efficient educational experiences. These tools support students in exam preparation, leading to improved test outcomes. However, while talking about the benefits of AI in education, some researchers also raised concerns regarding the challenges that intersect sustainability awareness and positive perceptions of AI in education (Fošner, 2024). Concerns have emerged about AI's potential to cause existing biases and discrimination. For example, a study by Nikadimovs and Vēvere (2024) highlights generative AI's varying performance across different disciplines, demonstrating strong results in fields like economics and programming but weaker results in mathematics that can affect students' trust in AI's accuracy and reliability in an educational context. However, existing literature demonstrates that AI technology for enhances personalized learning through tailored support, information retrieval, and critical thinking encouragement, which can shape positive perceptions of AI among students. The importance of AI in education can be determined by the study of Yeh et al. (2021), witnessing that nearly two-thirds of students use AI tools with significant use in linguistics, engineering, mathematics, and natural sciences, creating a growing familiarity with AI among higher education students. According to (Okulich-Kazarin et al., 2024), despite some prevailing ethical concerns AI use in education, positive perceptions among students still prevail. Researchers (See Alismaiel et al., 2022; Relmasira et al., 2023) have suggested that students need to develop a balanced perspective on AI, promoting both critical engagement and an understanding of AI's potential for promoting sustainable, equitable learning practices. This awareness of AI's implications can shape students' perceptions, eventually affecting how they integrate AI into their educational journey.

2.3 Sustainability Awareness and Learning Engagement

Sustainability awareness and learning engagement are defined as students' knowledge about the importance of sustainable practices, their impact on society, and their further inclination to prefer technology in education. Here, Zhou and Hou (2024) cited an example of second language learning (L2 education). As noted, the progression of language education has evolved from dependence on computer-aided instruction to the modern phase of AI technology integration, characterized by advanced intelligence, big data analytics, and intelligence learning systems. This shift has sparked interest in examining the impacts of AI on different learning dimensions, i.e., personalized and interactive experiences. This evolution has been driven by innovations in academic framework, advances in educational technology, and the ethical dilemmas surrounding education. Wang et al. (2023) further investigate the effects of learning models on Chinese English and Foreign Language (EFL) learners, indicating that the learners' psychological needs significantly affect their interactions with the relevant technology. Yeh et al. (2021) further emphasized the significance of user-friendliness in the adoption of modern technology in education, especially for vocabulary acquisition among English learners, indicating that perceived usefulness can affect learners' engagement with technology. Another study Lin et al. (2024) examined university English language instructors' perspectives concerning the integration of AI technology into language instruction, indicating some concerns about its usage. However, the same study also indicated an overall positive perception among instructors regarding AI in enhancing students' engagement to promote sustainability in education.

2.4 Sustainability Awareness and Educational Motivation

AI has become a transformative tool in education, reshaping traditional teaching and learning methods and further widening access to education globally (Alotaibi, 2022). AI offers unique capabilities to strengthen educational programs that promote awareness in advancing sustainability, encourage sustainable practice, and promote a mindset focused on long-term positive impacts. One of the main benefits of using AI in education is its ability to personalize the learning experience (Louati et al., 2024). According to Hsieh et al. (2020), AI can process extensive data to understand individual learning styles, preferences, and strengths by using advanced algorithms and machine learning. This allows AI-based platforms to design educational content, spacing, and delivery to meet each learner's specific needs, maximizing engagement and retention to improve the effectiveness of sustainability education. Besides, AI enables the creation of immersive, interactive learning environments beyond conventional educational approaches and will serve real-time feedback and assessment through AI to further support educators in tracking progress by pinpointing areas needing improvement and intervening when necessary. Adaptive algorithms can help teachers design strategies based on learner's performance, ensuring targeted technology-facilitated instruction that maximizes engagement (Hsieh et al., 2020). AI-powered analytics also provide insights into student engagement, knowledge gaps, and misunderstandings, helping educational institutions determine the shortcomings regarding technology in education and methods to improve its performance (Shwedeh et al., 2024). According to Fošner (2024), AI-driven educational tools motivate collaboration and community involvement by improving individual learning. The social networking features, peer-to-peer interactions, and collaborative tools, AI-based platforms help build a sense of community and shared responsibility among learners. These educational initiatives can inspire collective efforts to address sustainability challenges, driving positive effects on local, national, and global scales by connecting individuals with similar interests and objectives. Therefore, considering the cited theoretical and empirical literature, this research proposes three preliminary research hypotheses.

H1. Sustainability awareness has a positive effect on Perceptions of AI in Education

H2. Sustainability awareness has a positive effect on Learning Engagement

H3. Sustainability awareness has a positive effect on Educational Motivation

3. Methodology

This study employs quantitative research design as the focusing on collecting data from English and World literature students from the two universities in the UAE and the Kingdom of Saudi Arabia. The design was selected to allow efficient data collection and ensure the robustness and generalizability of results (Gaus, 2017). The data were collected through structured, closed-ended questionnaire designed using a five-point Likert scale. Informed consent was obtained prior to conduct the full-scale survey. The respondents were notified that their participation was voluntary and the researchers would refrain from using their personal data for any commercial purposes, and an ethical approval was obtained.

Table 1 presents details regarding the study questionnaire including sources and items. The data were collected from October 9 to November 1, 2024. Following the data collection, the researchers coded the collected data to proceed further with the data analysis using SPSS and Smart-PLS for Structural Equation Modeling.

Table 1. Details for the Survey Questionnaire Items and Sources

Variables	Items	Sources
Sustainability Awareness	I believe in minimizing resource use in education to support sustainability.	(Aktay, 2022)
	I understand the importance of ethical information-sharing as part of sustainability.	
	I am aware that digital tools can reduce the environmental impact of education.	
	I think about how my education can contribute to sustainable development goals.	
Perception of AI in Education	I support implementing sustainable practices (using technology) at my university.	(Farhi et al., 2022)
	I believe AI tools improve my learning experience in sustainable practices.	
	AI technologies make it easier for me to access information about sustainability.	
	I feel that AI plays a significant role in promoting sustainability in education.	
Learning Engagement	I view AI as a practical resource for improving my understanding of sustainable issues.	(Guruh Nuary et al., 2022)
	I feel more engaged in my studies when I understand their impact on sustainability.	
	Sustainability topics in my courses increase my interest in learning.	
	I participate more actively in class discussions when sustainability is a focus.	
Educational Motivation	Learning about sustainability motivates me to complete my assignments.	(Felix, 2020)
	Learning about sustainability inspires me to perform better academically.	
	I am more motivated to study when I see the relevance of sustainability in my courses.	
	Understanding sustainable practices makes me want to pursue higher academic goals.	
	I feel a sense of purpose in my education when I learn about sustainability.	

3.1 Population and Sampling

The study population comprised English and World literature learners currently enrolled at Ha'il University (KSA) and the Ajman University (UAE). Based on the criteria for sample selection in studies based on structural equation modelling, a sample of 200 respondents (100 from Ha'il University and 100 from the Ajman University) was initially set for the data gathering. The final sample of 171 valid responses was considered adequate for SEM-based analysis. As noted by Noor et al. (2022), the sample size of 100-200 remains suitable for studies employing structural equation modelling to ensure the generalizability of results. Further, the researchers used a random sampling approach for the respondents' selection to ensure that the selection was unbiased and fair. A detailed random sampling procedure was employed to ensure an unbiased and representative selection of participants from both Ha'il University and Ajman University. The researchers received a comprehensive list of English and World literature students enrolled in the relevant universities. They used a random number generator to select participants, ensuring each student had an equal possibility of inclusion. This method minimizes selection bias and improves the credibility of the findings. After the data collection, the researchers carefully evaluated each questionnaire. The final response remained 100% as the respondents filled and returned all the questionnaires.

3.2 Data Normality

Data normality was tested to determine the suitability of parametric tests in the current study (Mishra et al., 2019). Two standard normality tests, the Kolmogorov-Smirnov and Shapiro-Wilk, were conducted (Shatskikh et al., 2016). Table 2 shows the results of these normality tests. Because all p-values exceeded 0.05, the data did not significantly deviate from normality and can be considered normally distributed. Consequently, the use of parametric tests was appropriate for this research.

Table 2. shows the results of the Kolmogorov-Smirnov and Shapiro-Wilk normality tests

Variables	Kolmogorov-Smirnov ^a		Shapiro-Wilk	
	Statistics	Sign	Statistics	Sign
Sustainability Awareness	.466	.415	.415	.508
Perceptions of AI in Education	.501	.438	.395	.533
Learning Engagement	.504	.470	.485	.365
Educational Motivation	.428	.485	.576	.285

3.3 Respondents' Profile

The respondents' profiles are presented to highlight diversity in gender, age, education level, and institutional background. These factors may influence students' perceptions of AI, learning engagement, and motivation. This also ensures that the sample represents both the UAE and KSA contexts, thereby supporting the study's reliability. Upon calculating the descriptive of respondents' demographics, it was found that 69% were females and 30% were males. However, the significant gender imbalance, with females representing nearly 70% of respondents, may affect the findings, potentially limiting their generalizability across genders. –These factors may affect students' perceptions, engagement, and motivation differently. Recognizing these demographic variations is crucial when interpreting results, and future research may benefit from using stratified sampling or subgroup analyses to better understand these dynamics. Regarding age, 45% of respondents are 24-27 years old, 31% are 28-31 years old, 19% are 17-22 years old, and 4% indicated that they are 32 years old or above. Including this group broadens the study's scope and captures a more diverse student population engaged in English language learning,

which is particularly relevant in GCC institutions where alternative educational pathways are common. Finally, 53% of students are from Ha'il University, and 46% are from the Ajman University. Table 3 represents a summary of the respondents' demographic profiles.

Table 3. Summary of Respondents' Profile

Variables	Construct	N	%
Gender	Female	119	69.6%
	Male	52	30.4%
Age	17-22	33	19.3%
	24-27	77	45.0%
	28-31	53	31.0%
	32 or above	8	4.7%
Institution	Ajman University	80	46.8%
	Ha'il University	91	53.2%

4. Data Analysis and Findings

Data analysis in this research is based on a two-phase approach, including the reliability and validity assessment of the measurement model and further testing of the structural model suggested by Nunkoo and Ramkissoon (2012).

4.1 Measurement Model Testing

Regarding the measurement model testing, this research used confirmatory factor analysis (CFA). Table 4 shows the results of CFA. The analysis showed that most factor loading values exceeded the minimum threshold of 0.50. Besides, all the Average Variance Extracted (AVE) values are also above the threshold value of 0.5 (Sustainability Awareness 0.735, Perceptions of AI in Education 0.793, Learning Engagement 0.815, Educational Motivation 0.752). The analysis further revealed the Cronbach alpha and composite reliability values as well. Findings showed that all the Composite Reliability values (Sustainability Awareness 0.712, Perceptions of AI in Education 0.801, Learning Engagement 0.788, and Educational Motivation 0.745) and Cronbach Alpha values are above the threshold value 0.7 (Sustainability Awareness 0.760, Perceptions of AI in Education 0.821, Learning Engagement 0.799, and Educational Motivation 0.774). These results indicated the validity and reliability of the measurement model in this study.

Table 4. presents the results of the Confirmatory Factor Analysis (CFA)

Variables	Items	Loadings	AVE	CR	CA
Sustainability Awareness	SAW1	0.862	0.735	0.712	0.760
	SAW2	0.739			
	SAW3	0.703			
	SAW4	0.697			
	SAW5	0.689			
Perceptions of AI in Education	PER1	0.682	0.793	0.801	0.821
	PER2	0.681			
	PER3	0.689			
	PER4	0.472			
Learning Engagement	ENG1	0.592	0.815	0.788	0.799
	ENG2	0.808			
	ENG3	0.759			
	ENG4	0.646			
Educational Motivation	MOT1	0.632	0.752	0.745	0.774
	MOT2	0.840			
	MOT3	0.830			
	MOT4	0.684			

The model fit analysis is further conducted to ensure the suitability of the measurement model for the structural model assessment in the latter stages. According to Schermelleh-Engel et al. (2003), model fit is analyzed to determine the extent to which observed value fits well with the expected value. Table 5 shows the summary of model fit analysis. First, Tucker and Lewis values remained at 0.846 which is between the designated threshold ranging from 0-1. The Standardized Root Mean Square value is 0.005, which is below the threshold value of 0.005, the Non-Fit Index value remained at 0.936 (between 0-1), and the Chi-square value is at 2.537, which is below the threshold value of 3.0. Overall, these results show a good fit of the measurement model.

Table 5. Model Fit Assessment

Acquired Value	Threshold Value
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TLI	0.846	b/w 0-1
SRMR	0.005	<0.008
NFI	0.936	b/w 0-1
Chi-square	2.53762	<3.0

Further, the discriminant validity of the measurement tool was assessed using the Fornell-Larcker criterion, one of the most preferred techniques in Structural Equation Modelling (SEM). Results revealed that the calculated squares roots of all Average Variance Extracted values (AVE) not only surpass the correlation values in the given table but also do not correlate. These findings confirm that discriminant validity was established in the current study model. Table 6. presents the results of the Fornell–Larcker criterion for discriminant validity.

Table 6. Discriminant Validity Results Based on the Fornell–Larcker Criterion

	Sustainability Awareness	Perceptions of AI in Education	Learning Engagement	Learning Motivation
Sustainability Awareness	0.540			
Perceptions of AI in Education	0.469	0.628		
Learning Engagement	0.398	0.614	0.664	
Learning Motivation	0.456	0.589	0.578	0.565

4.2 Structural Model Testing

Before testing the structural model, the predictive power of Sustainability Awareness in relation to Perceptions of AI in Education, Learning Engagement, and Learning Motivation was evaluated, also known as the coefficient of determination (R^2). Table 7 presents the results of the coefficient of determination (R^2) analysis. Results indicated a 66.2% variance in Learning Motivation (Strong), 63.5% variance in the Perceptions of AI in Education (Strong), and 40.9% variance in Learning Engagement. Overall, these results indicate a satisfactory predictive power of Sustainability Awareness on dependent variables in the current study.

Table 7. Coefficients of Determination (R^2) for Dependent Variables

Variables	R^2	Strength
Perceptions of AI in Education	0.635	Strong
Learning Engagement	0.409	Moderate
Learning Motivation	0.662	Strong

Finally, path analysis is conducted to test the proposed study hypotheses based on cause-and-effect relationships among constructs. As noted by Streiner (2005), path analysis is one of the most preferred approaches in regression-based modelling because it provides deeper insights into the relationships among latent variables. Despite the fact that regression is widely applied, path analysis provides in-depth details of the underlying values, including beta coefficients, t-values, means, standard deviation, and significance. Thus, the researchers first examined the proposed effect of sustainability awareness on perceptions of AI in Education. With a path value of 0.472 and a significance value of 0.000, the proposed hypothesis remained significant.

Regarding the second hypothesis, the beta coefficient value of 0.613 and significance value of 0.000, the proposed effect of sustainability awareness of learning engagement also remained significant. Finally, results showed a beta coefficient value of 0.273 and a significance value of 0.000, implying that the effect of sustainability awareness on educational motivation also remained significant. Results also revealed that the path between sustainability awareness and learning engagement remained strongest among all (0.613). Followed by the path between sustainability awareness and perceptions of AI in education (0.472), the path between sustainability awareness and educational motivation remained weakest among all (0.273). Table 8 summarizes the results of path analysis of the proposed hypotheses.

Table 8. Hypotheses Testing

Hypotheses	β	M	STDEV	 O/STDEV 	P values	95% Confidence Interval	
						2.50%	97.50%
Sustainability Awareness -> Perceptions of AI in Education	0.472	0.675	0.061	9.353	0.000	0.336	0.727
Sustainability Awareness -> Learning Engagement	0.613	0.524	0.043	23.200	0.000	0.487	0.79
Sustainability Awareness -> Educational Motivation	0.273	0.630	0.078	6.899	0.000	0.537	0.848

4.3 Sensitivity Analysis

A sensitivity analysis was conducted across demographic groups to assess the stability of the hypothesized paths. The path coefficients for

gender groups (male and female) showed minimal differences, indicating that the relationships remained stable regardless of gender. Across the age groups (17–22, 24–27, 28+), the coefficients remained consistent, suggesting the effects of sustainability awareness on perceptions of AI, learning engagement, and educational motivation were stable across age categories. The path coefficients across the two universities (Ajman and Ha'il) were also comparable, reinforcing the generalizability of the findings across institutions. Overall, these results indicate that the relationships between sustainability awareness and educational outcomes were robust and generalizable across the major demographic subgroups within the sample. Table 9 presents the results of the sensitivity analysis.

Table 9. Results of Sensitivity Analysis

Path Relationship	Gender Male	Gender Female	Age 17-22	Age 24-27	Age 28+	Ajman Univ.	Ha'il Uni
Sustainability Awareness → AI Perceptions	0.45	0.49	0.46	0.48	0.44	0.44	0.50
Sustainability Awareness → Learning Engagement	0.59	0.62	0.60	0.63	0.58	0.60	0.63
Sustainability Awareness → Educational Motivation	0.25	0.28	0.26	0.28	0.24	0.26	0.29

5. Discussion

According to Alqahtani et al. (2022), sustainable awareness has a profound impact on contemporary education. It aims to build skills required for meeting social and environmental standards both now and in the future, including not just educational content but also an inclination towards adopting the approaches that may ensure social and environmental sustainability (Islam et al., 2023; Mazumder, 2016; Umar et al., 2020). Consistent with the conceptualization of constructivist learning theory, this sustainability awareness is an important aspect. Students' perceptions and positive attitudes towards Artificial Intelligence technology help them embrace and use the relevant technology for productive learning outcomes (Relmasira et al., 2023). These outcomes may include their increased interest in AI technology to improve their perceptions about the relevant phenomenon and improved learning engagement (See Louati et al., 2024; Mutambik, 2024), further leading to enhanced educational motivation among students. The focus of this research also remained the same, aiming to investigate how sustainability awareness remains an important phenomenon, further leading the students to have positive perceptions about AI use among English language learners in two major higher educational institutions in the GCC region (Ajman University and Ha'il University). Findings indicate strong agreement among respondents regarding the role and effect of sustainability awareness in integrating AI in education for constructive outcomes.

Talking specifically about the gathered data, respondents expressed their awareness of sustainability principles. They reported believing in minimizing resource use in education to support sustainability as they understand the importance of ethical information-sharing as part of sustainability. Regarding sustainability awareness, respondents indicated that they are aware that digital tools can reduce the environmental impact of education and, further, how their learning can contribute to achieving the Sustainable Development Goals (SDG). Respondents agreed that they support implementing sustainable practices particularly through the use of technology at their universities. Consistent with the responses, Zulkarnaen et al. (2023) argued that sustainability awareness is closely linked to the competency of self-awareness in education for sustainable development, indicating individual responsibility in addressing different social, economic, and environmental issues. The goal of sustainability awareness is to encourage students to actively support sustainable development in the 21st century, preparing them to mitigate the risks that threaten natural and social resources. Consequently, higher education institutions play a crucial role in promoting sustainability awareness and support students in adopting resource-efficient approaches, such as technology usage that reduces resource consumption (Alotaibi & Alshehri, 2023b; Farhi et al., 2022; Louati et al., 2024).

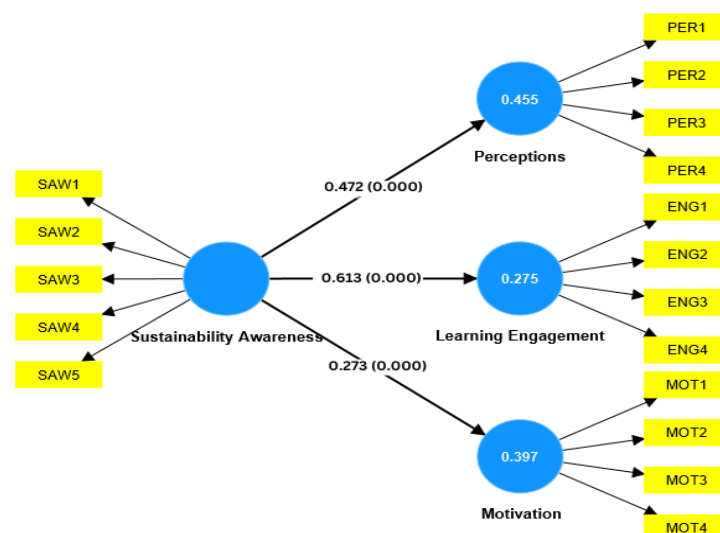


Figure 2. Final Structural Model (Path values, P values)

Regarding the study hypotheses, the first proposition stated that “H1”. Sustainability awareness has a positive effect on Perceptions of AI in Education”. Results indicated that this hypothesis was statistically significant, implying a strong agreement from respondents. The path between sustainability awareness and learning engagement showed the strongest effect, indicating that students with higher awareness of sustainability tended to be more actively engaged in their learning process. This may be attributed to the fact that sustainability themes are often interdisciplinary, socially relevant, and action-oriented, aligning well with constructivist principles that promote active, meaningful learning. For English and World Literature students, engaging with texts through a sustainability lens (e.g., eco-criticism) fosters personal relevance and emotional investment, thereby increasing participation, discussion, and critical reflection. In other words, respondents agreed that they believe that AI tools improve the learning experience in sustainable practices as these technologies make it easier to access information about sustainability. Respondents also consented that they feel that AI plays a significant role in promoting sustainability in education. Consequently, respondents viewed AI as a practical resource for improving their understanding of sustainable issues. In their study, Vázquez-Parra et al. (2024) also examined the perceptions of Mexican students regarding AI integration in higher education. Quantitative data collected from university students highlighted positive perceptions regarding AI integration in the educational sector, emphasizing that learners value technology in education. Respondents highlighted that it is important for educational institutions to incorporate modern technology to fulfil their academic needs. Consistent with the current research, existing literature (Vinuesa et al., 2020; Zulkarnaen et al., 2023) indicates that positive perceptions of students allow universities to craft educational strategies that effectively integrate AI, ensuring that these tools align with students' educational goals and professional aspirations. These findings offer noteworthy and significant insights, as students not only consider AI as a helpful tool for learning but also strongly associate it with promoting sustainable educational practices. This positive link between sustainability awareness and AI perception was more pronounced than expected, indicating that learners recognize AI's role not only in academic support but also in addressing global sustainability challenges. Interestingly, students viewed AI as a means of enhancing access to sustainability-related knowledge, suggesting a deeper, value-driven engagement with technology than is typically assumed. Linking these results to the constructivist learning theory emphasizes the importance of active, meaningful engagement when students connect new knowledge to real-world issues and challenges. Sustainability awareness provides exactly that bridge. When students perceive their learning as contributing to broader societal or environmental well-being, their intrinsic motivation and cognitive engagement increase. Within literary studies, exploring texts through eco-critical or socially conscious lenses encourages students to reflect critically, question assumptions, and emotionally invest in learning. This alignment between personal values (e.g., sustainability) and the curriculum fosters deep engagement, as supported by Vygotsky's concept of the zone of proximal development—students are more likely to stretch their thinking when the learning content is relevant, value-based, and scaffolded by supportive tools like AI.

Furthermore, the second hypothesis, “H2. Sustainability awareness has a positive effect on Learning Engagement”, also remained significant, suggesting a consensus from respondents regarding the effect of sustainability awareness affecting their learning engagement. The moderately strong path suggested that students who value sustainability also tend to view AI more positively, likely because they perceive it as a tool that can support eco-friendly and ethical learning (e.g., paperless classrooms, access to global knowledge, personalized learning). Literature students, while perhaps less technologically oriented than STEM students, may still appreciate AI when it is framed as a facilitator of ethical and sustainable education, particularly in GCC contexts where technology integration is rising alongside policy commitments to sustainable development. According to study respondents, they felt more engaged in studies when they understand their impact on sustainability. In addition, sustainability topics increase their interest in learning. The respondents also opined that they participate more actively in class discussions when sustainability is a focus, as learning about sustainability motivates them to complete assignments. In

line with these results, Shwede et al. (2024) also emphasized the role of sustainability awareness in enhancing students' learning engagement. As noted, when students are aware of the different aspects and importance of sustainability, they are more engaged in their educational journey. Students are more likely to connect personally with the material, promoting a deeper commitment to their education. This awareness promotes active participation and encourages students to apply what they learn to real-world challenges, improving both critical thinking and problem-solving skills. According to Dai and Ke (2022), it also indicates the role of educators can inspire a sense of responsibility at purpose, which in turn increases students' motivation and dedication to their learning journey. Thus, an interesting finding from this result is that sustainability awareness directly boosts students' learning engagement, not just theoretically but in practical classroom behaviors, i.e., increased participation and motivation to complete tasks. What particularly unexpected is how strongly students tied personal relevance and real-world impact to their academic interests. The finding that sustainability topics motivate deeper involvement suggests that when education connects with global challenges, students feel a stronger sense of purpose, leading to more meaningful and active learning. Additionally, positive perceptions of AI are more likely when learners view it as a tool that supports ethical and responsible learning within the constructivist AI framework. Sustainability-aware students may perceive AI as a means of reducing resource waste (e.g., paper), expand access to knowledge, and personalize education efficiently and inclusively. From a constructivist viewpoint, when students perceive technology as aligned with their values, i.e., equity, responsibility, or environmental care—they are more open to constructing positive meaning around its use. However, since literature students may engage with AI less frequently than students in technical fields, their perceptions may not be as strong, explaining the moderate effect size.

Finally, the third hypothesis, “H3. Sustainability awareness has a positive effect on Educational Motivation”, also remained supported”. This supported hypothesis indicated that respondents' agreement towards learning about sustainability inspires them to perform better academically. The respondents agreed that they felt more motivated to study when they see the relevance of sustainability in their courses. However, the relevant path showed the weakest relationship, though still statistically significant. It may indicate that while sustainability awareness does contribute to students' academic motivation, motivation is likely shaped by a broader set of factors, such as personal goals, cultural expectations, or institutional support. Literature students may not automatically see sustainability topics as central to their academic identity, which could explain the more limited influence. Additionally, motivation might be more indirectly affected, mediated by engagement or influenced by the perceived relevance of sustainability in their career pathways. According to the respondents, understanding sustainable practices makes them want to pursue higher academic goals as it helps them feel a sense of purpose in education when they learn about sustainability. Here Grubaugh et al. (2023) linked sustainability awareness with sustainability education to improve motivation among students. As stated, incorporating motivation as a core learning objective in education has been a fruitful approach. Consistent with this argumentation, a study by Islam et al. (2023) examined the effect of educational motivation regarding motivation. Findings also implied the significant effect of sustainability awareness through education to promote among them. According to constructivist theory, motivation is most effectively triggered when learners feel autonomy, competence, and relatedness. While sustainability awareness may promote a sense of purpose or ethical alignment, it may not directly fulfill personal academic goals or self-efficacy beliefs, especially for Literature students who may not yet see the practical or career-linked benefits of sustainability in their field. In constructivist settings, motivation thrives when learning is both personally relevant and skill-enhancing. Thus, unless sustainability is deeply embedded in the literature curriculum (e.g., through AI tools for textual analysis or eco-literary themes), its influence on motivation remains limited. Engagement may act as a mediator; students first become engaged due to sustainability, and then motivation is enhanced as a secondary outcome. A notable and significant finding here is that sustainability awareness strongly enhances students' educational motivation by giving their studies a clear sense of purpose. Hence, students become more driven to achieve academically when they recognize the real-world relevance of sustainability in their courses. This relationship between sustainability and motivation indicates that combining these themes can inspire students to set higher goals and engage more deeply with their education.

5.1 Implications

The results of this study revealed that students' awareness of sustainability significantly affects their perceptions of AI in education, learning engagement, and motivation. As noted earlier, according to constructivist learning theory, students learn best when they actively connect new knowledge to real-world contacts. This research shows that when students recognize the value of sustainability, they are more likely to view AI tools as beneficial for promoting sustainable practices within their studies. This suggests that educators should introduce AI not just as a technology but as a means of supporting meaningful, real-world applications. For English language educators in the UAE and the Kingdom of Saudi Arabia, integrating sustainability into AI-based learning activities can help students understand the role of technology in addressing global challenges, making their education feel more impactful. Besides, this study highlights that sustainability awareness can significantly improve students' engagement in learning. When sustainability-related topics are integrated into the curriculum, students are more inclined to participate actively and engage deeply, as these topics connect to their values and experiences. This approach is consistent with constructivist principles that emphasize the significance of relevance and learning. Educators can create more interactive, motivating learning environments by linking coursework to real-world sustainability issues. Specifically, in English language courses, this might involve using sustainability-related materials for reading, discussion, or projects, promoting a classroom atmosphere that promotes active learning and collaboration. Finally, awareness of sustainability also appears to influence students' educational motivation. When students perceive how their learning relates to broader societal goals, they are more likely to feel a sense of purpose and motivation to succeed. These results suggest that integrating sustainability into the curriculum can inspire students to pursue their studies with greater enthusiasm, as it motivates and reinforces the value of their education beyond the

classroom. Universities can further support this approach by incorporating projects and assignments that allow students to explore how their knowledge can contribute to sustainable development goals, thus promoting a deeper commitment to learning and personal growth.

Similarly, the findings of this study have significant implications for English and World Literature education in the GCC region. As countries like Saudi Arabia and the UAE pursue major educational reforms under initiatives such as Vision 2030, there is a growing emphasis on integrating digital innovation and the Sustainable Development Goals (SDGs) into higher education. The strong positive relationship between sustainability awareness and learning engagement suggests that incorporating eco-critical themes, global citizenship, and ethical responsibility into literature curricula can deepen students' association with the subject matter and make learning more relevant. Furthermore, the moderate effect of sustainability awareness on students' perceptions of AI underscores the potential to use AI tools, e.g., digital annotation platforms, text-mining tools, or AI-powered feedback systems, in ways that align with students' values. By incorporating both technological literacy and sustainability themes into literature courses, GCC institutions can better prepare students to address regional and global challenges while aligning literature education with broader national priorities.

6. Conclusion

This study highlights the importance of sustainability awareness among students, particularly in the context of higher education. Sustainability awareness equips students with the mindset to value resource conservation, ethical information sharing, and environmental responsibility. These attributes represent essential qualities for fostering a more sustainable future. For students studying in fields like English and World literature, integrating sustainability into their learning experience broadens their understanding of the world. It also emphasizes the relevance of their education in addressing global challenges. By promoting this awareness, universities can encourage students to consider their education as not only a path to personal growth but also a means of contributing to societal progress by promoting this awareness. Notably, Artificial Intelligence (AI) technology offers a powerful tool to further acquire this goal by supporting sustainable educational practices. AI applications in education, such as intelligent tutoring systems adaptive learning tools, personalized learning experiences, and optimize resource use, help ensure that students engage meaningfully with sustainability-related content. However, for students to effectively adopt and benefit from AI, greater emphasis on sustainability awareness is essential. Institutions can improve this awareness by embedding sustainability-focused projects, reflective activities, and interactive tools within the curriculum. This approach not only reinforces the positive impact of AI in achieving Sustainable Development Goal (SDG) but also aligns with constructivist principles, where students actively connect new knowledge to real world issues, leading to constructive most educational outcomes.

6.1 Study Limitations

Despite this study filling an important gap in existing literature, it has some limitations that future researchers can address. First, this research focused on only two universities in the GCC region, the Ajman University and Ha'il University, which limits the generalizability of the findings. Future researchers can replicate this study and conduct their own investigations in different regions to expand its scope and enhance generalizability. The second limitation concerns the use of a single methodology, the quantitative research design. Future researchers could adopt more comprehensive approaches, such as mixed-method designs, to broaden the scope of their research. The third limitation is based on selecting and analyzing only three aspects in academia: perceptions of AI in education, learning engagement, and educational motivation. However, there may be other different aspects that are directly and indirectly affected by sustainability awareness in educational arenas. By exploring additional aspects, future studies can provide further in-depth details regarding AI awareness and its integration into modern education to provide further policy insights.

Authors' contributions

Dr. Belal Ibrahim Zakarneh conceptualized and supervised the study, drafted, and approved the final manuscript. Dr. Fahad Aljabr conducted the literature review, supported data analysis, and edited the theoretical framework. Diana Amin Mohammad Mahmoud handled data collection, analysis, visualizations, and drafted the discussion. Dr. A. Nagaletchimee Annamalai wrote the methodology and reviewed the manuscript. Dr. Rim Chakraoui edited language and proofread the final version. Ahmed Yakoob managed data formatting, references, and compliance with journal guidelines.

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