The Role of Computer Simulations (CSs) and Artificial Intelligence on Student Learning: Moderating the Impact of the Learning Environment

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Abstract

The focus on student learning is crucial for educational institutions to remain competitive and has been the subject of recent research. This article investigates the influence of computer simulation and artificial intelligence (AI) on student learning in the UAE. This study examines the role of the learning environment in moderating the relationship between computer simulation, artificial intelligence (AI), and student learning in the United Arab Emirates (UAE). Primary data is collected by researchers through the use of questionnaires administered to students in educational institutions. The researchers utilised SPSS-AMOS to assess the reliability and relationships between variables. The findings indicate a positive correlation between computer simulation, artificial intelligence, and student learning in the United Arab Emirates. The findings indicate that the learning environment plays a significant moderating role in the relationship between computer simulation, artificial intelligence, and student learning in the UAE. This article provides guidance to regulators on establishing regulations that promote high student learning outcomes through the use of artificial intelligence (AI) and computer simulations.

Keywords: Computer simulation, artificial intelligence, learning environment, student learning, UAE.

1. Introduction

In the contemporary context, the progressions in technology have significantly revolutionised pedagogical approaches, ushering in a new era of possibilities for

augmenting student learning. Computer simulations (CSs) and artificial intelligence (AI) are two prominent tools at the forefront of this revolution, with the potential to significantly reshape the way in which students engage with educational content. Emprin (2022) asserts that these technologies not only facilitate interactive learning experiences but also enable the provision of personalised instruction tailored to the unique needs of individual students. The objective of this study is to examine the correlation between computer simulations, artificial intelligence, and the learning environment, specifically in terms of their combined impact on student learning outcomes within the context of the United Arab Emirates (UAE).

Gallagher (2019) conducted a study. The UAE is internationally recognised for its significant advancements and commitment to delivering high-quality education. The organisation has played a prominent role in incorporating technology into its operations. The nation's Vision 2021 aims to develop a knowledge-based economy and establish a globally competitive education system, acknowledging the significance of technology in achieving these objectives (Livsey, 2019). The incorporation of technologies such as computer simulations and artificial intelligence is pivotal in the execution of this ambitious plan.

According to Mawer (2022), the United Arab Emirates (UAE) has demonstrated a thoughtful approach in integrating technology within the realm of education. Over the course of several years, the nation has allocated resources towards the improvement of its technological infrastructure, resulting in a discernible influence on the educational system. The Smart Learning Initiative, implemented by the Ministry of Education, is a programme designed to incorporate cutting-edge technologies into educational settings. The integration of smart boards, e-learning platforms, and digital resources has become prevalent in educational environments. The integration of smart boards, e-learning platforms, and digital resources has gained significant acceptance, reflecting a conscious dedication to utilising technology for educational advancement (Conde, 2022). Computer simulations have become a valuable tool for immersive learning in this context. Huttar and BrintzenhofeSzoc (2020) discovered that simulations offer students the chance to interact with intricate concepts in a practical and experiential manner by recreating real-life scenarios within a virtual environment.

Artificial intelligence systems are being used more frequently to personalise learning by adapting instruction to individual students' learning styles, speeds, and preferences (Alam, 2022).

The integration of computer simulations and artificial intelligence has significant potential for enhancing the learning process and improving educational outcomes (X. Wang et al., 2020). Simulations enable students to participate in educational activities that are challenging to organise or ethically complicated by replicating real-life scenarios. Practical experience holds significant importance in disciplines such as science, engineering, and healthcare. Eltanahy, Forawi, and Mansour (2020) conducted a study. Computer simulations are being widely implemented in educational institutions in the UAE, where there is a strong emphasis on STEM (Science, Technology, Engineering, and Mathematics) education. Platforms such as Labster and PhET Interactive Simulations provide students with virtual laboratories, enabling them to perform experiments, manipulate variables, and observe outcomes in a secure and controlled setting. This approach enhances traditional laboratory work and promotes equal access to high-quality educational resources, enabling all students to engage in experiential learning regardless of their geographical or institutional limitations (Al Murshidi, 2019).

Artificial intelligence has revolutionised personalised learning by effectively analysing large volumes of data and making real-time adjustments (Guan, Mou, & Jiang, 2020). AI-powered platforms have played a crucial role in personalising instruction for individual students in the UAE, given the diverse learning styles, language origins, and educational demands present in the region. Song et al. (2022) examined the utilisation of adaptive learning algorithms in these systems to evaluate a student's strengths, weaknesses, and preferences. This leads to the creation of a personalised learning path that enhances comprehension and retention. AI is employed by language learning platforms like 'Duolingo' to adaptively adjust the difficulty and content of language learning activities according to a student's performance. This enhances the learning experience and fosters student autonomy and agency, enabling them to assume responsibility for their educational path. Personalised education has implications that extend beyond academic achievement, as it promotes essential skills

such as self-regulation, metacognition, and motivation (Emprin, 2022).

According to Hidalgo, Bucheli-Guerrero, and Ordóñez-Eraso (2023), the integration of computer simulations and artificial intelligence has the potential to significantly transform education. However, the effectiveness of these technologies depends on the specific learning environment in which they are implemented. Physical infrastructure, technology access, teacher preparation, and institutional support are a few factors that affect the success of these technologies (Al Darayseh, 2023). Unequal access to technology and infrastructure is a significant factor in the UAE's educational landscape, which encompasses urban private schools and remote state institutions. Educators' ability to effectively utilise and adapt educational techniques to these technologies is crucial. The purpose of this study is to assess the limitations of computer simulations and artificial intelligence on student learning outcomes in the unique learning environment of the UAE (Vanbecelaere et al., 2020).

The UAE is actively working towards achieving its Vision 2021, and the integration of advanced educational technologies, such as computer simulations and artificial intelligence, is essential for meeting its educational objectives. Livsey (2019) argues that these tools offer not only novel methods of knowledge dissemination but also personalised and engaging learning experiences that can potentially transform the educational landscape. This study seeks to explore the intricate connection between computer simulations, artificial intelligence, and the learning environment in the context of the United Arab Emirates. Through an examination of the application of these technologies in diverse educational contexts, our aim is to offer valuable insights that can inform policy-making, inform instructional methods, and ultimately contribute to the achievement of a knowledge-based future for the educational system in the UAE.

The study has several gaps. There is limited empirical research on the combined impact of computer simulations, artificial intelligence, and learning environments in the UAE context. Consequently, there might be a dearth of localised knowledge regarding the performance of these technologies in the specific educational context of the UAE. Furthermore, the United Arab Emirates (UAE) exhibits a wide range of learning environments, encompassing both well-equipped private schools and resource-constrained public institutions. Consequently, this diversity may lead to differing levels of

access to technology and teacher training. Understanding the influence of disparities on the impact of computer science (CS) and artificial intelligence (AI) on student learning outcomes is essential for developing inclusive educational interventions. It is crucial to investigate teacher perspectives, preparedness, and training needs for incorporating computer science (CS) and artificial intelligence (AI) into education. Additionally, it is important to address ethical concerns and privacy issues associated with data utilisation and algorithmic biases in educational technology. This comprehensive approach is essential for successful implementation.

Similarly, the study's findings have important implications for educational practice and policy in the UAE. Understanding the interaction between computer simulations, artificial intelligence, and the learning environment can inform effective strategies for integrating technology in education, tailored to the specific requirements of students in diverse educational settings. Additionally, gathering data on educators' preparation and training requirements can inform the development of professional development programmes. These programmes aim to equip teachers with the necessary skills to effectively utilise emerging technologies. Understanding the potential challenges and ethical issues related to technology-enhanced learning can guide the establishment of standards and safeguards to ensure student privacy and equitable access to educational resources. This study comprises five sections: literature review, methodology, data collection, discussion, and conclusion.

2. Literature Review

The integration of computer simulations into education has emerged as a transformative approach in the United Arab Emirates (UAE). Research consistently demonstrates that simulations are effective in facilitating student learning through experiential learning and increased engagement. Simulations enhance student engagement in the learning process through interactive and experiential activities within virtual environments (Chernikova et al., 2020). This aspect is integral to the UAE's educational focus, which prioritises practical and applied learning. A study conducted in UAE schools demonstrated that the inclusion of physics simulations in the curriculum resulted in heightened student engagement and notable improvements in conceptual knowledge

(Huang, Silitonga, & Wu, 2022).

Oladejo et al. (2023) emphasise the significance of computer simulations in addressing resource deficiencies within the educational system of the United Arab Emirates (UAE). Simulations can serve as a viable alternative when there is variability in access to physical laboratories or specialised equipment. This is particularly crucial in the case of schools located at a significant distance or facing financial constraints, as they may have limited access to standard laboratory resources. Jacobson, Levin, and Kapur (2019) found that computer simulations addressed resource limitations and facilitated inclusive, hands-on learning opportunities for students from diverse backgrounds. Simulations have demonstrated their efficacy in fostering critical thinking and problem-solving skills, which are highly valued in the educational system of the UAE. Simulations enhance analytical thinking and the practical application of theoretical knowledge by presenting students with complex scenarios and challenges.

Based on Winsberg (2019) study, UAE students who were exposed to computer simulations experienced notable enhancements in their problem-solving abilities. This suggests a strong correlation between simulation-based learning and the advancement of higher-order cognitive skills. Computer simulations offer personalised learning experiences, which is a notable advantage (Hussein et al., 2019). Simulations have the potential to customise education based on individual learning styles, speeds, and preferences through the use of adaptive algorithms. This is particularly crucial in the UAE's diverse educational setting, where students may have different linguistic backgrounds, learning abilities, and prior knowledge. Weiqing Wang et al. (2020) found that personalised instruction using simulations improved outcomes for students with diverse learning needs.

The integration of computer simulations into UAE education aligns with Vision 2021, which emphasises a knowledge-based economy and a high-quality educational system (Alkaabi, 2022). The UAE is strategically positioning itself to equip its students with the necessary skills and competencies to succeed in a rapidly changing global environment. This is being achieved by utilising technology to enhance the learning process (Livsey, 2019). The comprehensive examination of the corpus of material emphasises the significant role of computer simulations in enhancing student learning

in the United Arab Emirates. Therefore, we make a hypothesis that,

H1: *Computer Simulation has a positive impact on student learning.*

In contrast, the United Arab Emirates (UAE) stands out as a country that prioritises educational excellence and technical innovation. Consequently, the integration of artificial intelligence (AI) in education is reshaping the learning environment in the UAE. AI innovations have demonstrated their transformative potential as tools that offer numerous benefits for student learning. In the context of the United Arab Emirates, personalised instruction, which is a fundamental aspect of artificial intelligence, is recognised as a powerful tool. AI platforms utilise sophisticated algorithms to adapt the distribution of content in order to cater to various learning styles, preferences, and pacing. The adaptability demonstrated in studies conducted by Wang, Sun, and Chen (2023) enhances comprehension and retention. It also facilitates seamless integration with the diverse student population and individualised learning profiles in the UAE.

Moreover, the potential enhancement of diversity and accessibility through the implementation of AI is a topic of significant interest. AI language learning tools are crucial in the UAE due to the significant variation in linguistic backgrounds. AI is utilised in language learning programmes such as Duolingo and Rosetta Stone to offer flexible educational experiences, eliminating language barriers and facilitating widespread access to education (Huang et al., 2022) .emphasise the role of AI technologies in creating inclusive learning environments that consider the linguistic diversity prevalent in the UAE. AI integration transforms assessment practices by automating grading and providing prompt feedback to students. This practice benefits both educators by expediting evaluation procedures and students by offering prompt feedback on their progress and areas for improvement. The UAE greatly values its invaluable effectiveness in its pursuit of educational excellence. Chen, Chen, and Lin (2020) found that AI-based assessment systems improve grading efficiency and provide more comprehensive feedback, benefiting educators and students.

In addition to assessment, AI applications are increasingly focused on enhancing cognitive skills, which play a vital role in the UAE's knowledge-based economy. AI-powered platforms promote critical thinking, problem-solving, and analytical reasoning among students. These skills are essential in an ever-evolving global environment. Nguyen

et al. (2023) found that AI-based educational interventions enhance students' acquisition of higher-order cognitive abilities, which is in line with the objectives of the UAE's Vision 2021. The UAE can greatly benefit from implementing AI in education. AI aligns effectively with the educational objectives of the nation through its ability to deliver personalised instruction, enhance accessibility, streamline testing processes, and foster the development of crucial cognitive skills. The integration of AI in education is a strategic initiative that has the potential to enhance student learning outcomes. This effort aligns with the UAE's goal of achieving educational excellence and fostering a knowledge-driven future. Therefore, we make a hypothesis that,

H2: *Artificial Intelligence has a positive impact on student learning.*

The learning environment has a significant impact on the effectiveness of computer simulations for student learning, according to studies by Briffa et al. (2020) and Ahmed et al. (2019). The educational experience encompasses various factors, including physical, social, and psychological elements. The importance of the environmental standard is heightened when considering the integration of computer simulation. Simulations can enhance learning outcomes by promoting a positive learning environment. This environment includes well-equipped classrooms, conducive settings for collaborative learning, and supportive teacher-student connections (Qureshi et al., 2023).

Contemporary educational settings, equipped with advanced materials and technologies, provide an optimal environment for the seamless integration of computer simulations (Sandybayev, 2020). Hanaysha, Shriedeh, and In'airat (2023) argue that dynamic, interactive simulations offer students the opportunity to engage with complex concepts through hands-on experimentation and exploration. Research has shown that employing an active learning approach enhances students' retention and comprehension of intricate or challenging material. The impact of simulations in learning contexts varies. Simulations may not fully realise their potential benefits in environments with restrictive policies or limited resources (Al Rawashdeh et al., 2021).

The relationship between learning environments and computer simulations is particularly important in the UAE, a country known for its rapid technological progress and commitment to high-quality education. The UAE's commitment to providing high-quality educational facilities makes it a suitable environment for integrating technology-

based learning aids (Raji, 2019). An inclusive approach to education is necessary for a diverse student body comprising individuals from various countries and backgrounds. According to Mawer (2022) study, it is imperative to design learning environments that demonstrate cultural sensitivity in order to effectively cater to the diverse preferences and learning styles of students. The adoption of this inclusive approach fosters an educational setting wherein computer simulations can be effectively utilised by students of diverse cultural backgrounds, enabling them to access and derive educational advantages from such resources. We make a hypothesis from this study that,

H3: *Learning environment works as a moderator between computer simulations and student learning*.

According to recent research by Nuseir, Aljumah, and Refae (2022), the learning environment plays a significant role in moderating the impact of AI on student learning. The scope of this encompasses various elements, spanning from physical classroom layouts to social interactions and technological tools. The importance of maintaining a high standard for the environment becomes critical when incorporating AI technologies. The effectiveness of AI applications in enhancing learning outcomes relies on the existence of a supportive learning environment. This environment encompasses well-designed learning spaces, availability of advanced technology resources, and positive interactions between teachers and students (Huang, Saleh, & Liu, 2021). I has the capacity to revolutionise education through the facilitation of personalised and adaptable learning experiences. To cater to the unique needs of each student, these technologies have the capability to analyse individual learning styles and rates (Nguyen et al., 2023). Personalization fosters increased engagement and comprehension, leading to improved information acquisition and application.

The relationship between the learning environment and AI-driven learning initiatives holds great importance in the UAE, a country known for its advancements in technology and education. The UAE's commitment to advanced educational infrastructure makes it an ideal environment for the seamless integration of AI technology (Gallagher, 2019). The UAE requires an inclusive approach to accommodate its diverse student population, which encompasses individuals from various countries and cultural backgrounds. Based on the findings of Mawer (2022) study, it is imperative to take cultural

sensitivity into account during the design of learning environments in order to effectively cater to the diverse preferences and learning styles of students. The inclusive approach of incorporating AI-driven learning tools allows for effective engagement and educational benefits among students, irrespective of their cultural backgrounds. Another hypothesis we make out of this study that,

H4: *Learning environment works as a moderator between artificial intelligence and student learning.*

3. Research Methods

This article explores the effects of computer simulation and artificial intelligence (AI) on student learning. It also investigates how the learning environment moderates the relationship between computer simulation, AI, and student learning in the United Arab Emirates (UAE). Primary data is collected by researchers through the distribution of questionnaires to students in educational institutions. The constructs of computer simulation, artificial intelligence, learning environment, and student learning were measured using a set of questions. The questions for computer simulation were extracted from Choi et al. (2020), while the questions for artificial intelligence were taken from Ongena et al. (2020). The questions for learning environment were extracted from Halimah and Abdullah (2022), and the questions for student learning were taken from Ngereja, Hussein, and Andersen (2020).

Furthermore, the researchers obtain data from students attending educational institutions. The surveys were distributed to the students through in-person visits to the institutions. Additionally, the participants in the study were chosen through a simple random sampling method. Out of the 564 surveys sent by the researchers, only 295 valid surveys were received, indicating a response rate of 52.30%. In addition, the researchers utilised smart-PLS to assess the reliability and relationships between variables. Despite the use of complex models, the tool yields optimal results. The study employed two predictors, computer simulation (CS) and artificial intelligence (AI), as well as one moderating construct, learning environment (LE), and one predictive construct, student learning (SL). The constructs are presented in Figure 1.

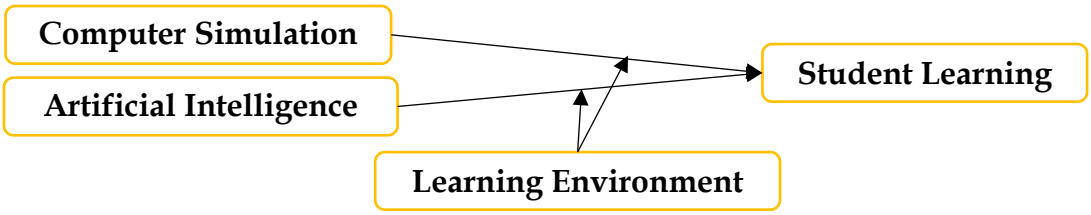

Figure 1: Research framework

4. Research Findings

The study findings assess convergent validity. Composite reliability is assessed by conducting checks, and the resulting outcomes should exceed a threshold of 0.70. AVE, factor loadings, and results above 0.50 were used to examine it. The analysis also includes the use of MSV and ASV, both of which have values lower than the AVE. These values indicate a stronger correlation between the items. The values presented in Table 1.

Table 1: Convergent validity

Constructs	Items			Loadings	CR	AVE	MSV	ASV
Computer Simulation	CS1	<---	CS	0.705	0.919	0.700	0.452	0.189
	CS2	<---	CS	0.985				
	CS3	<---	CS	0.751				
	CS4	<---	CS	0.703				
	CS5	<---	CS	0.988				
Artificial Intelligence	AI1	<---	AI	0.849	0.880	0.599	0.288	0.196
	AI3	<---	AI	0.833				
	AI4	<---	AI	0.837				
	AI5	<---	AI	0.627				
	AI6	<---	AI	0.697				
Learning Environment	LE1	<---	LE.	0.805	0.908	0.664	0.452	0.284
	LE2	<---	LE.	0.851				
	LE3	<---	LE.	0.827				
	LE4	<---	LE.	0.793				
	LE6	<---	LE.	0.798				
Students Learning	SL1	<---	SL	0.531	0.837	0.514	0.288	0.168
	SL2	<---	SL	0.813				
	SL3	<---	SL	0.607				
	SL4	<---	SL	0.799				
	SL5	<---	SL	0.788				

The study examines the discriminant validity of the findings. The Fornell-Larcker criterion was employed to assess the validity of the checks. The initial values in the column were found to be greater than the subsequent values. These values indicate a weak correlation between the variables. The values presented in Table 2.

Table 2: Discriminant validity

	LE.	CS	AI	SL
LE.	0.815			
CS	0.672	0.837		
AI	0.469	0.284	0.774	
SL	0.426	0.186	0.537	0.717

The study findings also assess the model's level of fitness. The TLI and CFI tests were conducted, yielding values exceeding 0.90. Furthermore, the examination includes the use of the Root Mean Square Error of Approximation (RMSEA), with test values below 0.05. These values indicate that the model is a good fit. The values presented in Table 3.

Table 3: Model good fitness

Selected Indices	Result	Acceptable level of fit
TLI	0.966	TLI > 0.90
CFI	0.977	CFI > 0.90
RMSEA	0.000	RMSEA < 0.05 good; 0.05 to 0.10 acceptable

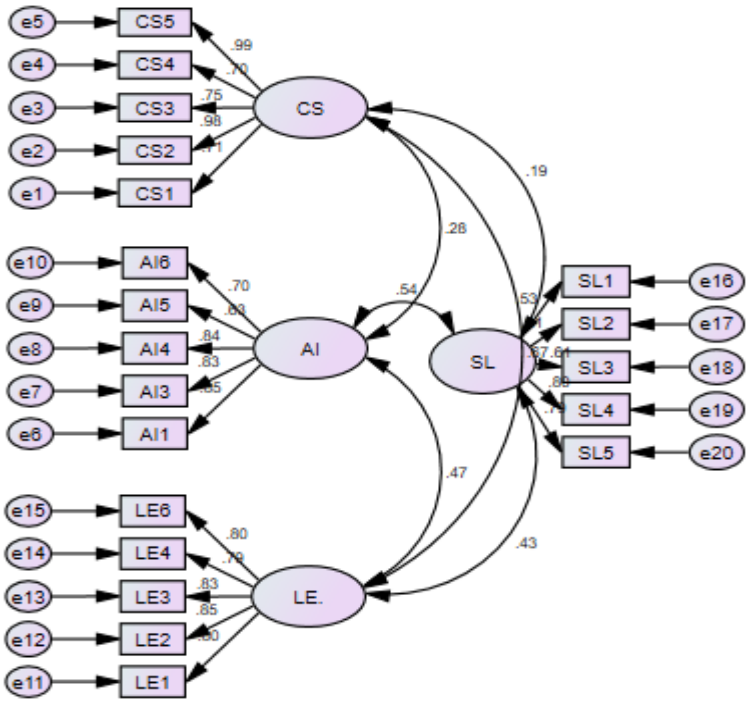

Figure 2: Measurement assessment model

The findings indicate a positive correlation between computer simulation, artificial intelligence (AI), and student learning in the United Arab Emirates (UAE), supporting hypotheses H1 and H2. Furthermore, the findings of the study indicate

that the learning environment plays a significant moderating role in the relationship between computer simulation, artificial intelligence, and student learning in the United Arab Emirates. This supports the acceptance of hypotheses H3 and H4. The connections are provided in Table 4.

Table 4: Path analysis

Relationships			Beta	S.E.	C.R.	P
Student Learning	<---	Computer Simulation	0.556	0.037	15.069	0.000
Student Learning	<---	Artificial Intelligence	0.024	0.004	6.000	0.000
Student Learning	<---	Learning Environment	0.453	0.037	12.273	0.000
Student Learning	<---	CS x LE	0.137	0.006	21.259	0.000
Student Learning	<---	AI x LE	0.092	0.007	13.159	0.000

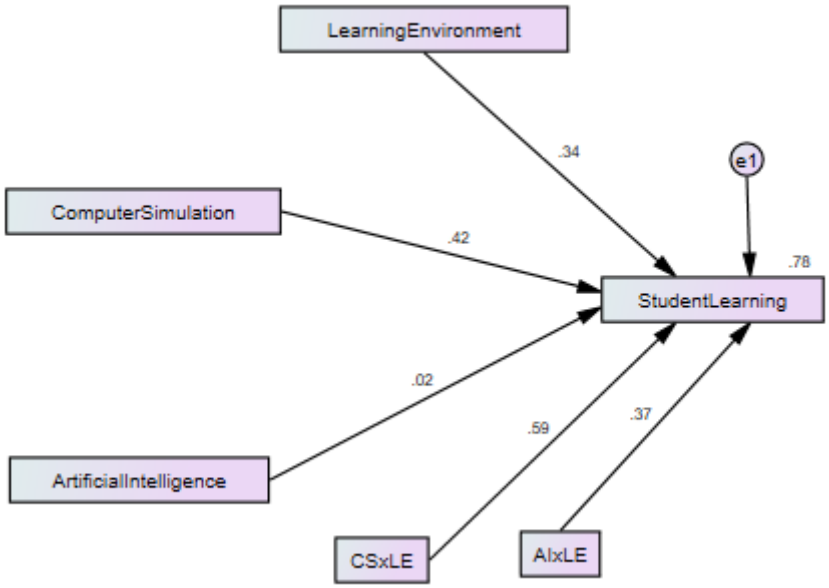

Figure 3: Structural assessment model

5. Discussions

This study examines the interaction between computer science (CS), artificial intelligence (AI), and the learning environment, aiming to determine how they collectively impact student learning outcomes. The integration of computer science (CS) and artificial intelligence (AI) in education has shown potential for enhancing learning experiences. This is achieved through the use of interactive and adaptable

tools that engage students in abstract and complex subjects. X. Wang et al. (2020) argue that the integration of CSs and AI in education has the potential to revolutionise the field. They suggest that this integration can enhance comprehension and retention by facilitating hands-on exploration and delivering personalised learning materials. The primary result of this study is the recognition of the learning environment as a crucial factor in determining the impact of computer simulations (CSs) and artificial intelligence (AI) on student learning. Briffa et al. (2020) and Nuseir et al. (2022) identified various factors, including physical, social, and psychological elements of the learning environment, that collectively influence the impact of educational technologies. A pleasant learning environment, characterised by well-equipped classrooms, access to technological resources, and encouraging teacher-student interactions, enhances the advantages of using CSs and AI (Qureshi et al., 2023). On the other hand, the advantages of these technologies may not be fully realised in environments lacking specific supportive elements.

This study holds particular importance within the UAE, a country renowned for its commitment to investing in technological innovation and educational excellence. The UAE's dedication to providing exceptional educational resources makes it an ideal setting for the smooth integration of computer science and artificial intelligence (Gallagher, 2019). The diverse student population, comprising individuals from numerous nations and cultural backgrounds, requires an inclusive mindset. Mawer (2022) emphasised the importance of cultural awareness in creating learning environments that cater to diverse tastes and learning styles. This inclusive approach fosters an environment where students from diverse cultural backgrounds can actively participate in computer science and artificial intelligence (CSs and AI) and reap the associated educational advantages. To ensure fair access and dependable AI-driven learning environments, it is crucial to address obstacles like technological disparities and concerns regarding data privacy and security. Livsey (2019) suggests that educators in the UAE and other regions can maximise the benefits of computer science (CS) and artificial intelligence (AI) by leveraging the moderating impact of the learning environment. This approach can create dynamic and inclusive learning experiences that effectively equip learners for success in the modern era. According to

Al Darayseh (2023), these technologies have the potential to revolutionise education by integrating them strategically and providing students with the necessary knowledge and skills to thrive in an increasingly complex and dynamic world.

Implications

This study has significant implications for educational practices within and beyond the UAE. To enhance student learning, it is crucial to prioritise the creation of a supportive learning environment that promotes the integration of computer science (CS) and artificial intelligence (AI). Educators in the UAE can utilise these insights to develop teaching strategies that effectively leverage these advanced tools. The report highlights the importance of inclusive learning environments, considering the diverse cultural backgrounds of students in the UAE. The integration of computer science (CS) and artificial intelligence (AI) in educational institutions necessitates a prioritisation of cultural sensitivity and adaptation. The study underscores the importance of providing educators with professional development opportunities. Teachers are equipped with the necessary information and skills to successfully integrate computer science (CS) and artificial intelligence (AI) into their teaching practices, leading to enhanced student learning outcomes. This article provides guidance for regulators in establishing effective regulations to enhance student learning outcomes through the use of artificial intelligence (AI) and computer simulations.

Limitations

While the study provides valuable insights, it is not without limitations. The generalizability of the results to diverse educational contexts with different cultural, social, and technological circumstances may be limited. This is because the findings are primarily based on the specific educational landscape of the United Arab Emirates. Therefore, caution and further validation would be necessary when applying these findings to significantly different educational settings. The study's conclusions are derived from an analysis of the current state of education at a specific point in time. The regulatory role of the learning environment can evolve over time as a result of the dynamic nature of technology and educational practices. Further investigation is

necessary to account for these anticipated enhancements. CSs, AI, and the learning environment have various interactions. While the study provides valuable insights, it may not fully capture the complexity of all relevant moderating factors.

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