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AI-Based Teacher Chatbots Fostering Self-Regulating Learning: Saudi Universities' Perspectives

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Abstract: Chatbots have secured public attention and researchers' interest in the education field to improve instruction and learning. The current study investigates the Saudi students' perspectives on fostering self-regulating learning utilizing artificial intelligence (AI)-based teacher chatbots. Data were collected from 393 undergraduate and postgraduate students enrolled in the summer semester at Ha'il University. The study found that the students had a positive perception of the AI-based teacher chatbot's role in fostering their self-regulating learning (motivation, strategy use, and behavioral change), utilizing their learning processes, with a focus on fostering behavioral change; allocation of effort and time for learning, seeking help behavior and peer learning, and actively setting their learning goals. The findings indicate a generally positive attitude toward AI chatbots as tools for enhancing learning experiences. Accordingly, the study suggested that AI-based teacher chatbots are viable for enhancing self-regulating learning consolidation among Saudi university students. It has the potential to foster independent learning habits, personalizing learning and improving academic achievement.

Keywords: artificial intelligence, chatbot, self-regulating, undergraduate students, Saudi university

1. Introduction

The use of chatbots has rapidly increased in recent years across a wide range of industries. Importantly, education is a crucial field where the use of chatbots is growing [1, 2]. Chatbots have drawn the attention of stakeholders in the educational sector as information technologies become more and more prevalent. Brookings institution's center for universal education published recently a report of a study spanning 50 countries, involving over than 500 students aged of 9–19 years old, it found that 95% in south Korean students, 94% of those in Australia, 80% in Singapore, and 58% in Argentina were used artificial intelligence (AI) chatbot at least once in a week or used generative AI tool on a regular basis. Furthermore, the study reported a higher prevalence of AI chatbot usage among male students compared to female students, with a more positive attitude and fewer concerns [3]. Likewise, a study conducted involving students in Swedish universities stated that more than a third of students used a chatbot in their learning [4].

AI chatbots, previously known as virtual assistants, are an AI-based program to understand, interact with, and respond to human needs. The chatbot is designed to engage with users in a conversational manner, either verbally or textually, mimicking human nature for an easy-to-use experience [5]. One of the custom-built AI chatbots is DialogFlow. DialogFlow is a framework for natural language processing (NLP) that integrates conversational user interfaces into various gadgets, applications, and bots [6, 7].

Chatbots have the ability to aid students' learning, provide interactive learning opportunities for them, and even improve the transition of secondary school pupils into a university setting or aid in boosting university enrollment. Using chatbots that participate in conversation and, for example, correct mispronunciations, spelling mistakes, and grammatical errors, AI technology could help students' self-learning of discipline information [8, 9]. AI chatbots have the potential to address students' engagement in online learning, the educational resources gap, expand access to education, and personalize the learning experience, tailoring learning to each student's needs. Certain technological advancements have pronounced human traits and may interact with students, creating interactive learning environments. As part of a proactive learning process known as self-regulated learning, students must take the initiative and devise techniques to learn using these tools [10]. On the other hand, chatbots can reduce the workload of instructors by serving as teaching assistants and taking on the role of tutors, for example, by responding to frequently asked questions from students, reminding students of forthcoming deadlines, or even by administering online tests [11–13].

These days, the quick creation and implementation of chatbots in education have been made possible by the more readily accessible computing power and communication technology, and chatbots are employed to improve instruction and learning [14]. These AI-powered chatbots are now primarily focused on augmenting each student's knowledge base, particularly in specialized subjects. These chatbots' core objective is to impart new

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knowledge akin to a human instructor [2, 8]. In higher education, chatbots can assist in enhancing present services, reducing personnel costs, and creating new services. The majority of education-related AI studies have emphasized the system [15, 16]. However, studies examining the adoption of learner technology, including chatbots, tend to prioritize technical expertise such as computer self-efficacy or digital literacy over subject-domain knowledge [8, 10, 17–20]. Likewise, a qualitative systematic review found that 14% of 230 studies investigated the AI tools to support self-regulated learning in higher education, 42% of them used quantitative experimental designs, 50% used a mixed method approach, and more than 50% focused on STEM subjects, 35% on language learning, and 14% on nonacademic areas [1].

Therefore, the current study investigates the Saudi students' usage of AI-based teacher chatbots and the potential for fostering self-regulating learning rather than the chatbot design.

2. Literature Review

1) AI chatbots in education

AI in education seeks to advance the creation of AI and AI-based tools and systems and explores how to apply them to enhance teaching and learning. The development of new learning models or learning algorithms, as well as their training, has been the main focus of a lot of research aimed at creating new educational tools and systems [2, 5, 21–24]. These methods and technologies frequently have a foundation in cognitive and learning sciences. For instance, adaptive learning systems may be created by training a predictive machine learning model employing system developers, AI tools, and an understanding of the learning process [11]. The result might be an AI-based tool for teaching certain skills that allow students to go through short learning modules with embedded formative evaluation, enabling the system to understand the student's needs. Relevant research has shown that intelligent AI systems with good design [21, 25–27], such as the Open Learning Initiative (OLI) learning course created by Carnegie Mellon University and Cognitive Tutor, can enhance student learning. In higher education settings, AI systems have the potential to greatly increase the efficacy and quality of student learning [12, 26].

AI and NLP are used in chatbots to communicate with human interlocutors at a specific level of discussion via text or voice [13]. Chatbots are virtual assistants that can respond to queries and give relevant answers, according to Essel et al. [6]. In order to react to their consumers, other writers used a text-based chatbot that commonly answers queries by adhering to a built-in rule set [6].

The capacity of students to communicate with teachers by asking questions is a crucial learning process that might improve academic achievement. Additionally, research has revealed that students are reluctant to raise questions since they are continuously afraid of receiving unfavorable feedback from their teachers. In order to address these problems, some teachers interact with their pupils outside of the classroom using social media platforms like Facebook Messenger and instant messaging services like WhatsApp [7, 11].

Systems or devices that resemble human intelligence and change on their own based on acquired data are referred to as AI. Chatbots are a type of software program that can comprehend queries more quickly and offer valuable responses [8, 22, 26, 27]. In this context, chatbots are useful when a course's teachers cannot respond to student questions in a timely manner to support their learning. Chatbots can replicate human-like dialogue-based interactive exchanges to aid students in reviewing learning resources, fostering learning accomplishment and self-efficacy, and boosting adaptive learning [9, 10].

Additionally, chatbots can help in overcoming this challenge by starting discussions based on the context of the learner, giving them the impression that they are being individually addressed. A chatbot can act as a go-between for a student and an instructor, allowing students to simultaneously manage their learning and development at their own pace without being constrained [14]. Additionally, chatbots often prompt inquiries from students who might be reluctant to participate in a traditional learning environment [15, 16].

These conversations mostly use text and speech; however, they might also include other media types like pictures, video, etc. Chatbots have been created from the start with the ability to instruct users on how to complete jobs [9]. They are currently fairly common in health-related situations, and research has proven their efficacy. More precisely, it appears that chatbots that use AI, NLP, and deep learning are the most successful [11, 17, 18, 21].

2) Self-regulated learning

Students frequently have more control over their learning process while participating in online learning activities. The degree of student self-regulation is substantially increased by the fact that students frequently pick "when" and "where" they will work on the online content [19]. Forethought, performance, and self-reflection are the three stages that make up the self-regulation hypothesis, according to Zimmerman [20, 21, 27], and each represents a process that takes place before, during, and following the learning endeavor [18]. The period when pupils become ready to study is referred to as the forethought phase. Goal setting, which refers to pupils choosing the desired results of an educational endeavor, is a crucial component of this phase. The term "performance phase" describes the application of techniques like self-monitoring to monitor learning progress. The self-reflection phase describes the processes that take place following learning, during which pupils consider their learning process and results. These introspections can affect later foresight procedures [21, 27, 28].

Students who can control themselves are more likely to perform better academically. However, a lot of online learners are unprepared for independent study and cannot self-regulate. Students may get disinterested in online activities as a result of this [10, 22, 27, 29]. Online learning is typically ineffective for students who cannot self-regulate their learning. Low self-control pupils frequently have lofty expectations for themselves, which can lead to disappointment after learning [22, 23, 30]. Previous studies have used a range of techniques, such as prompts embedded in lecture recordings, to assist students in setting objectives [18, 21, 23, 24].

Schellings et al. (2013) claim that there are four different categories of metacognitive approach [26].

1) Orientation: These are the techniques the subject used to define the cognitive requirements of the activity. These techniques direct the problem-solving procedure and activate the prior information required to solve a problem.
2) Planning: These techniques enable the process of completing tasks or overcoming difficulties to be broken down into a series of phases.
3) Evaluation: By enabling monitoring during the problem-solving process and enabling assessment of the phases in the resolution process, it is possible to determine if they were successful or not and, if not, to refocus planning as necessary.

4) Elaboration: These metacognitive techniques, which represent the greatest degree, include self-reflection on one's own behavior. Depending on the conclusions, the learner might adjust the technique and procedure during a task or problem-solving process.

3. Research Methodology

3.1. Research design

The study conducted a descriptive examination aimed at investigating and exploring both undergraduate and postgraduate students' attitudes toward utilizing AI-based chatbots in their learning processes to foster self-regulated learning and behavioral change. Self-regulated learning, in the current study, is defined as the process by which students can regulate their cognition, motivation, and behavior to attain their learning goals as defined by Zimmerman [20]. Accordingly, the study adopted three pillars as a design foundation of the instrument, including how the students engage with chatbot tools (behavior), a cognitive perspective on how students perceive chatbots as a solution for their problems (strategy use), and how they accept and perceive chatbots' usefulness (motivation). Furthermore, the study employed descriptive statistics methods, including the use of frequencies, standard deviations, means, and exploratory graphs. Additionally, variance tests were utilized as a measure of departure statistics to deduce differences among respondents that could be attributed to any demographic variable, if such existed. A normality test was also conducted to ensure the data's normal distribution, validating the choice between parametric and nonparametric tests.

3.2. Participants

The study's sample consisted of randomly selected undergraduate and postgraduate students enrolled in the summer semester at Ha'il University. The study instrument was distributed via students' emails provided by the university registration officer. Regarding the sampling technique, a random convenience sampling approach was adopted to ensure the representativeness of the students' sample. A pool of students' emails at Ha'il University was gathered for students who are enrolling in the summer semesters. Selecting a sample set of emails was done randomly using a random number generator.

It was assumed that the difference in sample means would be statistically significant at the 0.05 level, necessitating a total sample size of over 100, a figure commonly agreed upon by researchers. However, Cahan [31] pointed out that to avoid results that are not generalizable, increasing the sample size is a better strategy than narrowing confidence intervals. The selection of the sample was based on individuals being students at Ha'il University.

The participants were 393 students from Ha'il University. The male participants were higher than the female students (see Table 1). Using the simple random method and the consent of the participants, the participants were chosen at random.

Table 1
Distribution of the sample according to gender

Independent variable	Category	Frequency	Percentage
Gender	Male	312	79.4
	Female	81	20.6
	Total	393	100

3.2.1. Instruments

To assess students' perspectives following an introduction to the operations and functions of AI-based chatbots, an online questionnaire was developed. This questionnaire was designed in line with existing literature on chatbot adoption in education for self-regulating learning and learning behavioral changes, referencing studies such as [21, 23, 31].

The 5-point Likert scale was used in the survey. Options included Strongly disagree, Disagree, Neutral, Agree, and Strongly agree. Six Saudi university professors graded the poll, and it was revised while taking into consideration their suggestions. Before distribution, the survey was also given to a selection of study pilots to assess their level of ease, clarity, and comprehension. The survey was distributed to 37 students at Ha'il University. In the end, the survey was created and personally delivered to a sample of the study to get the necessary data and responses. The scale has satisfactory psychometric properties; Cronbach's alpha in the total sample was 0.87.

At the commencement of the research tools, a consent form was embedded to inform potential participants about the study comprehensively. The researcher was responsible for clearly stating the research objectives in the participation consent form, designing and statistically validating the questionnaire through a pilot study, distributing the questionnaire and ensuring participants' easy access to it, collecting data, cleaning it, and summarizing it in alignment with the research objectives.

The study used a 14-item questionnaire measure built by researchers after reviewing the educational literature and previous studies that dealt with AI-based teacher chatbots, and it made use of the studies [12, 24, 27, 31] and [15, 31] and modified some paragraphs to be suitable for students to answer. Each item of the 14 items was a statement that participants rated on a Likert scale. Each item corresponds to one of the three pillars aforementioned. The first pillar consists of items 3, 6, 7, 8, 10, 13, and 14, while items 2, 5, 9, and 11 measured the second pillar, and items 1 and 4 measured the third pillar.

3.3. Validity and reliability of the study

Content and construct validity: The design of the study questions drew from prior research on the topic of the study, and the measure's validity was established by giving the first copy to a panel of experts and soliciting their feedback. The final copy of the phrases was altered and rewritten for the research sample.

Reliability: Cronbach's alpha coefficient was utilized to guarantee reliability. The questionnaire's internal consistency ranges from 0.79 to 0.85, and its Cronbach's alpha is 0.87.

3.4. Data analysis

The Statistical Package for the Social Sciences (SPSS) version 28.0 was used to acquire the data's statistical analysis findings. Cronbach's alpha and Pearson's correlation coefficients were used to assess the scale's internal validity and reliability. Descriptive statistics were then used to characterize the frequencies, percentages, means, and standard deviations of each variable. Since the data were not normally distributed, the research used nonparametric tests. Finally, the Mann–Whitney U test and Kruskal–Wallis test analyses were used to assess variations in answers across genders and educational years. Application of

these tests goes beyond simple descriptive reporting; it finds differences across sample demographic characteristics, which add an empirical print not found in direct simple exploratory research in this context.

4. Results

4.1. Demographic profile of participants

A total of 393 students participated in the survey. The highest percentage of participants was male, accounting for 79% of total participation. Female participants represented just 21% of the study sample (Figure 1).

Figure 2 shows the distribution across educational years. It is worth pointing out that most of the respondents were in their first year, presenting 56% of the participation. However, the third-year category had the lowest representation, at 10%. According to Figure 3, 60% of participants disclosed a frequent utilization of chatbots for learning. In contrast, only 40% of students claimed to have never utilized chatbots in their learning.

4.1.1. Q1: Do AI-based teacher chatbots foster self-regulating learning?

To answer the question, descriptive statistics were used to find Saudi undergraduate students' perspectives on chatbots.

Figure 1
Sample distribution according to gender (*n* = 393)

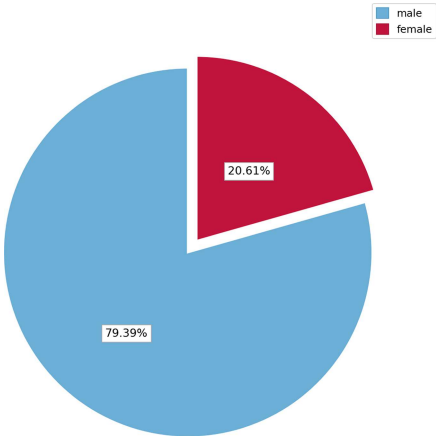


Figure 2
Sample distribution according to educational year (*n* = 393)

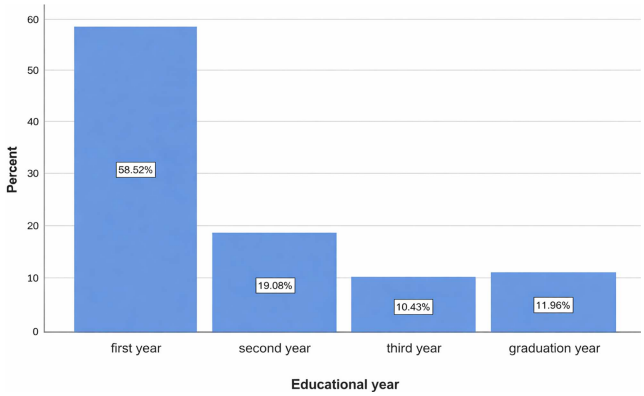
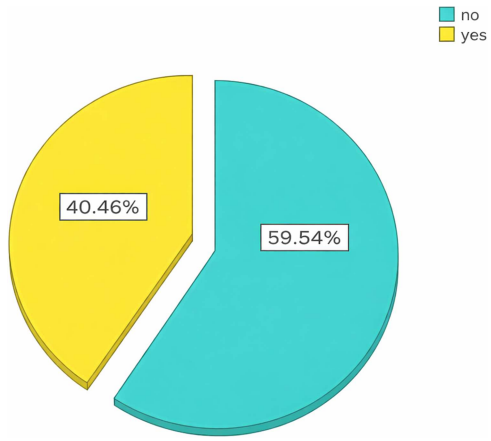


Figure 3
Have you ever used chatbots for your learning (*n* = 393)



Based on Table 2, the students with self-learning rate all items of chatbots at a high importance level, with a mean of 3.84. As shown in Table 2. Item (8) "Chatbots provide information in different ways, written, verbal, auditory, and visual" had a mean of 3.96 since percentages are 36.6%, 21.9%, and 2.8% for Strongly agree, Neutral, and Strongly disagree, respectively. The lowest mean was 3.73 for the item (1) "Using the chatbot enabled me to set my learning goals" since the percentages are 32.1%, 29.3%, and 3.3% for Agree, Neutral, and Strongly disagree, respectively.

1) Differences in the Saudi students' perspectives on AI-based teacher chatbots considering their gender and educational year

Finally, a Mann–Whitney *U* test was applied to investigate the different Saudi students' perspectives on AI-based teacher chatbots in both females and males. The Mann–Whitney *U* test is a nonparametric test since the data are non-normally distributed. The test examines the variables in measure according to gender (Table 3). Results from the Mann–Whitney *U* test indicated no significant gender difference in Saudi students' perspectives on AI-based teacher chatbots ($U = 12148.5$, $p = 0.591$). Taken mean rank and rank sum values, these results indicate that the Saudi students' perspectives on AI-based teacher chatbots of male students have higher results than those for female students, as illustrated in Table 3. (M. Rank female = 190.98, S. Rank female = 15496.50; M. Rank male = 198.56, S. Rank male = 61951.5).

To assess differences in the Saudi students' perspectives on AI-based teacher chatbots considering their educational year, the Kruskal–Wallis test is a nonparametric test since the data are not normally distributed. According to Table 4, there is a difference among the educational years in the Saudi students' perspectives on AI-based teacher chatbots, with a chi-square of (14.982) and a significant level (0.002) in favor of the second years, which have a higher mean (231.08).

5. Discussion

This study sought to explore undergraduate students' perceptions of utilizing AI-based chatbots in their learning processes, with a focus on fostering self-regulated learning and behavioral change. The findings indicate a generally positive attitude toward AI chatbots as tools for enhancing learning experiences. The positive perception is reflected through the overall mean scores, indicating that students find chatbots to be a beneficial tool in

Table 2
Percentage, means, and standard deviations of the degree of agreement for students with a chatbot as a teacher or learning resource (n = 393)

No	Item	Agreement					Mean	SD
		Strongly	Disagree	Neutral	Agree	Strongly		
1	Using the chatbot enabled me to set my learning goals	3.3	7.9	29.3	32.1	27.5	3.73	1.053
2	Using the chatbot made it easier to complete my goal-setting process	2.3	7.4	26.7	33.1	30.5	3.82	1.022
3	The chatbot enhanced my effectiveness in setting my learning goals	3.6	8.7	26.2	32.3	29.3	3.75	1.078
4	Overall, I found chatbot was useful in my learning	3.8	5.1	26.7	32.1	32.3	3.84	1.056
5	Chatbot provides additional exercises and activities to validate my learning	2.8	7.9	26.2	34.1	29.0	3.79	1.038
6	Chatbot allows profession intervention (handover) in advanced learning cases	4.8	9.2	27.5	30.5	28.0	3.68	1.120
7	Chatbot always supports me with additional resources to read or solve	3.8	5.3	25.7	32.3	32.8	3.85	1.060
8	Using chatbots, both long-term and short-term objectives were defined easily	3.1	6.6	24.9	33.8	31.6	3.84	1.040
9	Chatbots provide a suitable learning environment and learning style	2.5	6.1	24.4	31.3	35.6	3.91	1.034
10	Chatbot provides me with information in different ways, written, verbal, auditory, visual, etc.	2.8	5.3	21.9	33.3	36.6	3.96	1.026
11	Chatbot helps me summarize the knowledge in a suitable, readable, and presentable form	3.8	4.3	23.2	34.1	34.6	3.91	1.044
12	Chatbot helps me schedule my learning hours and rate during the day	2.8	4.6	24.4	34.9	33.3	3.91	1.004
13	Chatbots help me evaluate my learning outcomes	3.8	6.1	24.2	31.6	34.4	3.87	1.076
14	Chatbot can easily and explicitly define my evaluation criteria in terms of learning objectives	4.3	5.6	25.2	30.8	34.1	3.85	1.089
	Total means						3.84	0.86

Table 3
Results of a Mann–Whitney *U* test for differences in the mean scores of the male and female samples on AI-based teacher chatbots

Gender	*n*	Mean rank	Sum of ranks	Mean ± SD	*U*	P
Female	8	190.98	15469.50	3.836 ± 0.8626	12148.50	0.591
Male	312	198.56	61951.50			
Total	393					

Table 4
The Kruskal–Wallis test result for the Saudi students' perspectives on AI-based teacher chatbots according to educational year

Educational year	*n*	Mean rank	Chi-square (*df* = 3)	Sig.
First year	230	183.44		
Second year	75	231.08	14.982	0.002
Third year	41	230.96		
Graduation year	47	179.35		

their learning process. According to Zimmerman [30] and Apriani et al. [32], self-regulating learning has three stages; positive perception and interest in using a chatbot within the learning process reflect the forethought phase. Furthermore, the results also addressed positive perceptions toward goal setting, leveraging the capabilities of the chatbot. This corresponds to the self-reflection phase, as represented by the means of positive perception toward using a chatbot for setting long-term learning objectives. However, the performance phase is characterized by representing information in various formats and incorporates the role of a chatbot for evaluation and monitoring learning progress.

This finding aligns with the four metacognitive approaches of self-learning, which Schellings et al. [26] elaborated. According to current results, chatbots help represent information in various formats, which activate the prior knowledge, facilitate problem-solving, and break down the information and tasks as demonstrated and addressed in [21, 24, 32]. Likewise, the process of evaluation and elaboration is associated with self-monitoring, frequent assessment, and adjusting learning objectives. These aspects are consistent with the results of recent studies [21, 24, 32].

To sum up, chatbots foster self-learning by providing information in various formats, including written, verbal, auditory, and visual, which received the highest mean score. This suggests that students particularly value the versatility of chatbots for delivering content that caters to diverse learning styles and preferences, potentially enhancing the effectiveness of learning and fostering a more personalized experience. Students also appreciate the chatbots' ability to offer additional resources and exercises, support advanced learning cases, and create a conducive learning environment. Chatbots were also recognized for assisting with the definition of both short-term and long-term learning The results demonstrated the value of chatbots for enhancing the learning experience through the diverse delivery of educational content and providing supplementary resources instantly. This suggested a strong case for integration into learning systems, and prioritizing chatbot features in e-learning system designs aligns with students' preferences and needs.

However, the analysis also highlights areas for improvement. The lowest mean score was observed for the statement concerning the chatbots' assistance in enabling students to set their learning goals. Although this remains within a positive range, it indicates that there may be opportunities to enhance how chatbots support students in the crucial initial stages of goal setting, which is a foundational aspect of self-regulated learning.

It is worth mentioning that the study sample was drawn from one university, limiting the generalizability of findings. Perceptions and usage of chatbots in education and learning could vary depending on the demographic and geographical location of the sample.

6. Conclusion

The study aimed to investigate the Saudi students' perspectives on AI-based teacher chatbots and their role in enhancing the self-regulating learning of the students.

The findings suggest that AI-based teacher chatbots are seen not only as a direct instructional tool but also as a facilitator for deeper exploration, understanding of topics, and self-assessment. The findings underscore the potential of chatbot technology to be further integrated with pedagogical strategies, enhancing self-regulated learning through increased customization and personalization capabilities. Moreover, these insights align with the need for empirical research exploring the measurable outcomes of chatbot integration in learning environments and how these outcomes correspond with existing theories of self-regulated learning. The positive student perceptions revealed in the analysis serve as a promising foundation for ongoing research and development in the field of educational technology, highlighting the importance of addressing both technological and pedagogical considerations in the design and implementation of AI-based learning tools. The study findings carry out chatbot analysis in higher education, supporting the proposal of a distinct architecture for a chatbot learning system considering differences in chatbot utilization across different educational years. Furthermore, based on findings, any future architecture must consider privacy and data security properties and the significance of personalized feedback and design.

Future studies are encouraged to reconduct the research to investigate these nuances across a more diverse range of universities and geographic areas. Despite the current findings establishing a solid foundation for understanding students'

behavior, motivation, and strategy use, further studies are encouraged to assess chatbots' impact on self-regulated learning and behavioral changes by employing experimental designs that would expand causal inferences about their effectiveness.

Ethical Statement

All subjects provided informed consent for inclusion before participating in the study. The study was conducted in accordance with Al-Ha'il University's Institutional Review Board, Saudi Arabia.

Conflicts of Interest

The author declares that he has no conflicts of interest to this work.

Data Availability Statement

Data available on request from the corresponding author upon reasonable request.

Author Contribution Statement

Yousef Almoslamni: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration.

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