



Check for
updates

Research Article

This article is published by Scientific-Board in the Research Journal in Translation, Literature, Linguistics, and Education (RJTLLE). Volume 1, Issue 1, 2025.

ISSN: 3067-6290 (Online)

Print (Pending)

Article Details

Received: 20 March 2024

Accepted: 10 December 2024

Published: 02 January 2025

Conflict of Interest: The author/s declared no conflict of interest.



How to Cite:

Using Generative Artificial Intelligence Models (GAIM) as digital assistants for enhancing motivation and retention proficiency of mathematics undergraduates. (2025). *Research Journal in Translation, Literature, Linguistics, and Education (RJTLLE)*, 1(1), 39-55.

Using Generative Artificial Intelligence Models (GAIM) as digital assistants for enhancing motivation and retention proficiency of mathematics undergraduates

Yousef Methkal Abd Algani^{1*}, Mohanad Ahmad Shini¹

¹The Academic Arab College for Education in Israel-Haifa, Israel

*Correspondence author email: yosefabdalgani@gmail.com

Abstract

Artificial intelligence has significantly revolutionized academic activities, offering learners varying systems that help them overcome the limitations of traditional teaching and learning methods. In this paper, the focus was to critically analyse how the consistent use of GenAI chatbots may increase motivation and increase the retention capacity of undergraduates in Mathematics. Self-determination theory was applied to explore how students go through motivation processes and how GenAI chatbots can increase their motivation. Also, Intelligent Tutoring Systems (ITSs) were applied as a conceptual approach to explore how GenAI chatbots can impact the cognitive and mental processes of the students to increase their retention ability in Mathematics learning. In the paper, a quantitative approach was adopted, and data was collected from 93 undergraduates through digitally designed survey questionnaires. The analysis was conducted using relevant statistical measures, including descriptive statistics, CFA, and Pearson correlation. We measured 14 items, which were referred to as indicators derived from previous studies. The results of the statistical analysis and the Pearson correlation tests indicated that GenAI chatbots directly enhance undergraduates' motivation and retention ability, which invariably impact their academic performance. The overall mean score was high, indicating regular usage of AI chatbots (mean = 4.18) and also that it played a crucial role in solving academic problems (mean = 4.05). Moreover, participants reported better understanding of the course materials (mean = 4.27) and quicker recall of information when compared to non-chatbot methods (mean = 4.02). The three hypotheses were accepted, suggesting that consistent use of GenAI chatbots increases undergraduates' motivation levels, enhances their retention ability, and increases their academic performance. Thus, we conclude that the transformation of AI chatbots into useful tools for undergraduates' academic growth has increased their motivation levels, enhanced their retention ability, and improved their academic performance.

Keyword: Generative Artificial Intelligence Models (GAIM), mathematics, motivation, retention proficiency



© 2025. This article is distributed under a Creative Common Attribution (CC BY-NC-SA) International License.

1. Introduction

Artificial intelligence models have become the dominant research interest in recent studies of the application of digital systems in the education system. According to Chiu et al. (2023), artificial intelligence in the education system entails the usage of artificial intelligence tools, including automated assessment and evaluation systems, automated writing assistance systems, AI-enhanced tutoring platforms, AI-powered chatbots, learners' collaborative platforms and other artificial intelligence drive systems in the education system. These tools are prominent in enhancing learner engagement and increase their interest in the academic activities. Over the years, previous studies in AI in education (AIED) have focused mainly on the development of different AI models and the direct impact on students' learning outcomes, including ethical concerns and the protection of academic integrity in the era of AI. Arrays of systematic literature reviews have identified four main themes that are dominant in the area of AIED, including the themes of learning, teaching, assessment and administration. This observation majorly implies that studies have not critically looked into the impacts of the use of generative artificial intelligence (GenAI) as digital assistants to enhance the motivation and retention capability of undergraduates.

Motivation and retention capability are two psychological and mental factors that consistently impact on the academic performance of undergraduates. Similarly, retention ability, which is seen as the capacity to consistently remember previously taught information and data, is another mental process that have not been critically studied in relation to GenAI in FL education. In an attempt to boost the academic achievement and motivation and retention ability of undergraduates, an increasing number of institutions are emphasizing the implementation of novel teaching strategies and materials. Numerous studies have found that motivation greatly impacts students' academic achievement by making them strive harder to gather knowledge and get involved in the learning process (Ali et al., 2023; Du & Mo, 2024; Hmoud et al., 2024). Nevertheless, conventional educational resources, including printed sources and lectures, have very specific constraints when it comes to developing motivation for learning in the twenty-first century. Likewise, the usual education structure for encouraging the memory ability of undergraduates calls for more advanced technology to alert students to important information (Alsarayreh, 2021).

The first thing to mention about the effects of GenAI on improving the motivation and retention ability of undergraduates is largely predicated on AI's capability to infuse interactive elements, individualized learning experiences, and tactics for meeting students' individualized needs (Huang et al., 2023; Khasawneh et al., 2023; Forsman et al., 2022). Substantial AI-based tools could revolutionize the learning process by overcoming these barriers. AI has the ability to power individual and adaptive learning, thereby increasing students' tendency to know. A large number of studies have shown the success of artificial intelligence programs in supporting enthusiasm and overcoming the shortcomings of traditional educational resources (Azamatova et al., 2023; Alam, 2023). Despite the growing body of studies on the impacts of AI in the transformation of learning experiences for students, there is still a lack of evidence in academic literature about the exact influence of these tools on university students by supporting motivation and increasing retention ability.

The primary aim of this paper was to fill this research gap by investigating the impact of artificial intelligence-enabled teaching aids on the academic motivation and achievement of undergraduate students.

2. Review of Theoretical Framework and related Studies

There are currently thorough assessments of research on two topics: motivation and the effects of AI on Mathematics learning. Several studies have shown that students' intrinsic desire leads to improved academic performance and, ultimately, better levels of competency. The use of AI in classrooms has also

been investigated. In this part, we will go over these topics, primarily to set the stage for the analysis and provide the theoretical groundwork for the research.

2.1.Theoretical Framework

To effectively explore how GenAI can enhance motivation and increase students' retention capability, there is need to integrate a theory with an analytical mode. In the analysis of motivation as a core component of learning process, Self Determination Theory (SDT) was considered suitable, while the analysis of retention capabilities of the students was analysed using Intelligent Tutoring Systems (ITSs). Fundamentally, ITSs are GenAI based when explored from the lens of enhancing retention memory of the students. But, SDT is a social theory that is applied in this study as a system to explore how the use of GenAI as digital assistants can help students enhance motivation wherein the end goal is to increase academic performance of the students.

Ryan and Deci (2020), as cited in Moybeka et al. (2023) put up Self-determination Theory (SDT) as a means of better understanding what motivates people. Many researches in many fields have shown SDT, and one of those areas is how to improve the motivation of learners. It contends that students' psychosocial needs—autonomy, competence, and relatedness—must be met in order for them to develop self-motivation, which is the ideal incentive for learning that may result in higher levels of engagement and diligence. Researchers using SDT will have a better knowledge of the function of artificial intelligence-driven learning tools in connection to student motivation when these tools are continuously improved (Chiu, 2022; Palacios et al., 2021). Researchers such as Ryan and Deci (2020) have recently urged further study into how students are motivated to learn and the potential of current technological advances to enhance their learning. Nevertheless, no SDT-based studies investigating AIED in settings have been conducted so far.

According to studies conducted by Ali et al. (2023) and Chiu et al. (20223)., studies regarding education and technology centered around SDT has not exclusively proposed teaching strategies but have also highlighted the significance of supporting teachers' standards. The teaching methodology has a significant impact on how students of varying skill levels react (Petrovic & Jovanovic, 2021). GenAI Chatbots may provide more substantial assistance to students with higher levels of experience than to those with lower levels of expertise, leading to higher levels of intrinsic motivation for students with higher levels of competence to study independently (Hooda et al., 2022). Thus, for beginners studying with chatbots, it is more vital to have instructor help or supervision. No one knows what a chatbot's exact function is in the classroom; for instance, it may work closely with more advanced students as a facilitator or instructor, but just as a stand-in for more inexperienced pupils.

For educational technologies to be successful, students must possess self-directed learning (SDL) and digital literacy (DL). For instance, SDL and DL are necessary for effective platform discussion, online data analysis, and multimedia presentation creation (Alam, 2023). Consequently, even though chatbots may provide tailored instructional materials, students with varying SDL or DL levels may see them differently. How people see things may affect what they do in response to criticism. For example, if a student knows that chatbots can only understand low-quality speech (DL), they might try speaking more slowly and clearly or switch to text input (SDL) while dealing with chatbots.

On the other hand, Intelligent Tutoring Systems, (ITSs), are AI-powered technological learning aids. Based on students' strengths and weaknesses, these systems may personalize lessons, pacing, interfaces, and feedback. It is typical to focus on the learners' cognitive, affective, and metacognitive capacities (retention). In the first, we have information processing; in the second, we have emotions as we learn; and in the third, we have cognitive monitoring.

According to Vrabie. (2023), these models combine computer methods from several fields such

as “mathematics, computational linguistics, computational neuroscience, computational learning, and cognitive sciences”. Sleeman and Brown (1982), as cited in Villega-Ch (2023) first used the word ITS to describe an overview of “Intelligent Computer-Aided Instruction (ICAI)”, which initially primarily concentrated on the subject information (Crawford et al. 2024). In order to effectively assess students’ structures, skills, and/or learning styles and modify instruction appropriately, and ITSs should have domain knowledge, learner knowledge, and understanding of instructional methodologies, according to Essel et al. (2022).

Most ITSs concentrate on three primary areas: cognition, emotion, and metacognition. The first two deal with mental operations like processing information and retention, the third with the knowledge and control of thought processes, and the fourth with the sentiments and emotions that accompany learning (motivation). Although some systems, like Wayang Outpost, address all three domains, most ITS only address one (Alshewiter et al., 2024). It wasn’t until the 1980s that Cognitive Tutors—a kind of Intelligent Tutoring System—became well-known for mental aid, or assistance with analysing data (Hazaymeh et al., 2024). Following the turn of the century, Affective Tutoring Systems—ITSs that focus on affect, or sentimental and emotional support—have grown in prominence (Du & Mo, 2024). Contrarily, research on ITSs with a metacognitive emphasis date back to the 1980s, with publications like Chiu et al. (2023) and Palacios et al. (2021) coining the term “intelligent tutors that scaffold metacognition” to describe these systems.

The development of chatbots have been considered as advanced functionality in the general understanding of ITSs, wherein the system functions as a digital teaching assistant to the students. This is the area where the significance of GenAI as chatbots become significant. The chatbot systems such as ChatGPT, Google Bard and the recently announced Microsoft Copilot, are considered affective systems to develop ITSs that can help students to get individualised learning systems in enhancing retention capacity.

2.2.Motivation and Retention in Mathematics Education; an Overview

The level of intrinsic motivation demonstrated by undergraduates has a substantial impact on their acquisition, especially in an official learning environment (Ali et al., 2023). An analysis of multiple components—intelligence, linguistic proficiency, and most significantly, motivation—is entailed in the investigation of proficiency. Considerable emphasis is placed on the latter, which is a crucial element within this academic discipline. As stated by Silitonga et al. (2023), proficiency is a combination of an individual’s diligence, desire to learn, and positive outlook on the educational journey (Singh & Hiran, 2022; Obidoya, 2024; Pipia et al., 2024). At present, the general consensus in the field of motivation research is that motivation can be conceptualized as a spectrum of differing levels of intensity, spanning from zero percent to one hundred percent (Du & Mo, 2024; Hmoud et al., 2024; Khaswaneh et al., 2023; Neji et al., 2023; Huang et al., 2023). The significance of motivation in the context of learning cannot be overstated, given that it provides the fundamental drive to commence and maintain the rigorous and time-consuming learning process.

On the other hand, students’ retention is regarded as an aptitude for receiving, retaining, and replicating what they have experienced (Alsarayrah, 2021). Since the educational results of students in schools are determined by their thorough understanding of the content, which is inextricably linked to the act of recalling information, good retention is essential for all students to learn most effectively. Students will be capable of learning effortlessly and attaining the best possible educational results if they are able to maintain informed information. If they could effectively process information, students might possess powerful memories (palacios et al., 2021; Forsman et al., 2015).

One of the measurements of the educational approach’s effectiveness was the course material

that was covered. Information is encoded, stored, and resurfaced in memory, which is the process by which information is retained over time. Data retained in memory over time is the result of its transfer from short-term memory. The extent to which information can be retained in long-term memory and remembered accurately for future problems or at specific moments can be used to measure retention. However, empirical evidence continues to indicate that student retention remains inadequate (Vrabie, 2023).

In most cases, academic achievement is determined by the degree to which learners have mastered the material covered. Students' ability to retain the concepts taught in their long-term memory (retention) is a further indicator of the standard of education that must be assessed in order to determine the efficacy of the approach to learning. According to a survey result by Crawford et al. (2024), a mere 60% of instructors express an interest in employing learning strategies that facilitate students' retention of acquired knowledge in their long-term memories. By actively involving students in their educational experience, retention could be enhanced. Learning models and strategies have an impact on the recall of information and the comprehension of concepts.

2.3.GenAI Tools to Enhance Motivation and Improve retention in Mathematics Education

The principal objective of integrating GenAI into the realm of learning is to enhance the motivation and retention of students. Software applications driven by GenAI possess the capability to provide customized learning experiences that accommodate the distinct needs and preferences of individual students, thus augmenting their levels of engagement and motivation and retention throughout the educational journey. In this instance, the implementation of chatbots, which are machines that have the capacity for interaction, has shown positive behavioral effects on the students' motivation, retention, and engagement through the provision of personalized feedback and guidance (Moybeka et al., 2023). As stated by Alam (2023), the learners have the opportunity to use personalized digital assistants that give them feedback and suggestions that correspond with their specific learning style.

GenAI systems can analyze the learning data of learners and instantly provide them with feedback about their strengths and what needs improvement. This skill helps students discover areas of weakness and make improvements over time. According to Grajeda et al. (2023), the use of automated scoring machines improves students' engagement and motivation, which in turn increases their retention as they correct intonation and pronunciation in real-time. In the words of Essel et al. (2022), using interactive teaching programs that are adjusted to the progress as well as present motivating and challenging situations to the learners does highly increase the learners' motivation and their retention to continue their study. In fact, the introduction of GenAI-powered applications may lead to increased engagement and interest among la learners, thus helping to fuel their motivation and retention. Obidoya et al. (2024) state that the combination of augmented and virtual reality technologies can aid in the creation of realistic learning environments where students can not only step into the shoes of the characters but also express themselves in a natural manner as they would in a real-life scenario. Kamalov et al. (2023) argue that the combination of machine learning and speech recognition through GenAI can help enhance the quality of learning. This may lead to an improvement in their learners' motivation and retention and in their confidence.

3. Study Methodology

3.1.Study Design

To critically analyse the impacts of GenAI tools in improving the motivation and retention abilities of students in Mathematics in an effort to increase their academic performance, quantitative study design was adopted. The choice of quantitative study is to enable direct statistical measurement of items for

motivation and retention in relation to the use of GenAI and increase in the academic performance of the students. Quantitative measures involve the gathering of numerical data through surveys.

3.2. Study Questions

The following research questions were developed as the basis for selecting measuring items:

- i. How does the frequent use of GenAI tools impact on the motivation of undergraduates?
- ii. How can the consistent use of GenAI models improve the retention capability of undergraduates?
- iii. In what ways do the students' motivation and retention ability enhanced through the consistent use GenAI tools increase the academic performance of the undergraduates?

3.3. Survey Hypotheses

The following hypotheses were tested in the study:

- a. There is a correlation between the consistent use of GenAI chatbots as digital assistants and the increase in the motivation level of the undergraduates.
- b. There is a correlation between the consistent use of GenAI chatbots as digital assistants and the improvement in the retention capability of the undergraduates.
- c. There is a correlation between the consistent use of GenAI tools as digital assistants to enhance motivation and retention capability and the increased academic performance of the undergraduates.

3.4. Conceptual Model for the Study

The conceptual model is based on the projections of the dependent, mediator and independent variables as shown in the diagram below:

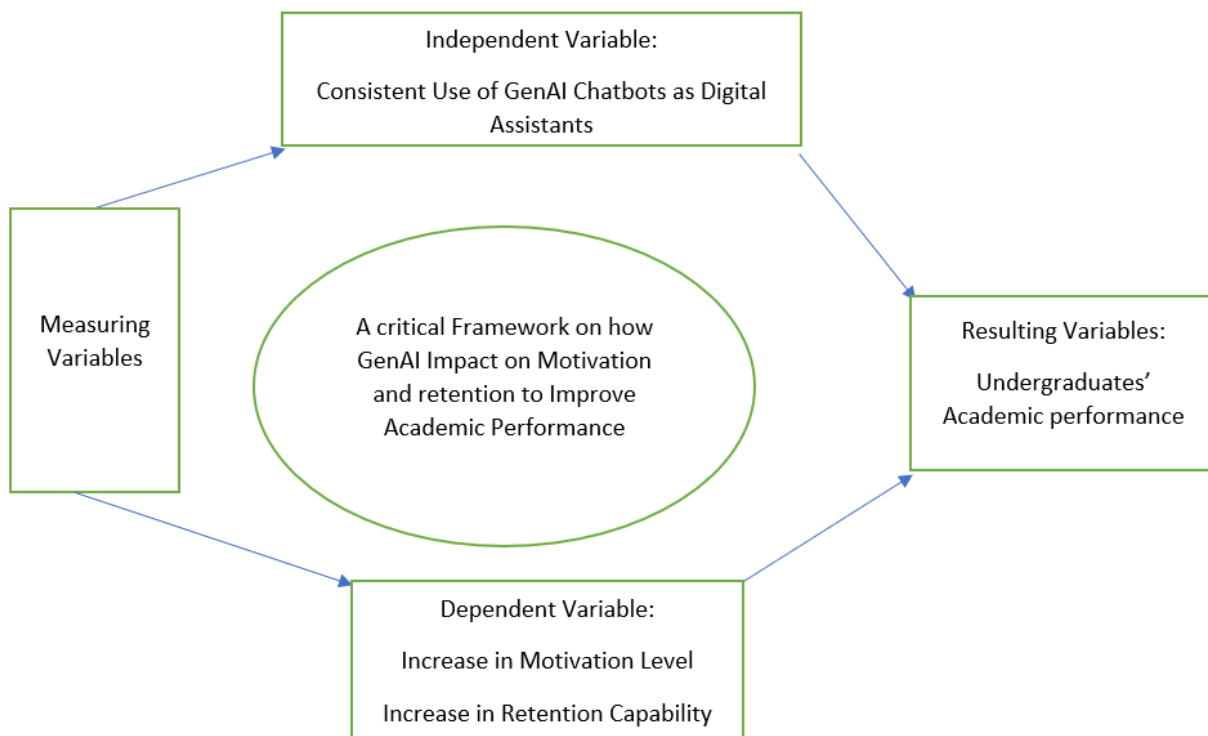


Fig.1: Conceptual Model for the Study

The focus in the developed conceptual model is to account for how the continuous use of GenAI

chatbots as digital assistants by undergraduates in Mathematics can enhance their level of motivation in learning and as increase their retention ability. The resulting variable is considered to be an increase in the academic performance of the students. This model guided the understanding of how undergraduates consistent and ethical use of GenAI chatbots as digital assistants has the capacity to transform their motivation and enhance their retention capacity, which invariably lead to increase in their academic performance.

3.5.Study Sampling

Randomised sampling strategy was used to select the study population considered suitable for this paper. The researchers shared digitalised designed survey to various social media platforms and groups, aimed at gathering current undergraduates studying in different universities. Initially, 167 undergraduates in Mathematics from 23 different Colleges\universities globally indicated interest to participate in the study through filling and returning of the consent form. However, about 93 undergraduates, which is 55.820% of the 167 persons hat initially indicated interest, actually returned the survey questionnaire given to them. The table below offered brief summary of the demographic features of the study participants.

Table 1: Summary of demographic features

Category	Group	Repetition No.	Percentile %
Gender	Male	39	42.14
	Female	54	57.86
Academic Level	Final	66	70.91
	Other levels	27	29.09
Age Bracket	19 years and below	29	31.55
	20-25 years	60	63.96
	26 years and above	4	4.49

From the survey result, there is an indication that the female participants dominated the study population, wherein over 57% are female participants, compared to less than 43% that are the male participants, this gender disparity may point to the fact that they may be more female students across different universities than their male participants. Other factors, including the contexts for data collection, may have influenced this variability. The data further indicated that most of the study participants are in their final year, at over 70%, while the remaining 29.09% are in other levels, including those in their penultimate years. Lastly, about 31.55% of the participants are 19 years or less, 63.96% are between 20 and 25%, while only 4.49% are 26 years and above. This age variability is indicative of the fact that the study population are mainly the younger people who are generally known to be active users of technological devices and systems.

3.6.Study Tools and Administration

To collect the required data, digitally designed survey questionnaires were distributed to the study groups. The questionnaire was designed using 5-points likert scale formats wherein the focus was on how the students accept or reject the statements. A total of 15 measuring items were derived across different studies for the measurement of motivation and retention increase following consistent use of technological tools (GenAI), and also the resulting academic performance of the students.

3.7. Method of Analysis

The Confirmatory factor analysis (CFA) was applied to evaluate and organise the items into constructs which is an approach or method to validate the measuring reliability of the items. This particular approach to analysis is considered very effective in validating the internal cohesion and validity of the used measuring survey items. In this study, the listed 14 survey items are known as indicators in the study, which are anchored on three factors. Factor 1 is the effective use of GenAI to enhance motivation, factor two is the consistent use of GenAI to enhance retention, while factor three is academic performance of the students. The nature of the collected data directly necessitates the use of CFA in the analysis. Also, simple regression analysis was further conducted in testing the three hypotheses.

4. Results and Discussion

4.1. Results

The results of the collected data are presented in different tables. The first effort was to present the summary of the descriptive statistics of the measuring items, and the validity of the study of the items, and the test of the three hypotheses.

a. Descriptive Statistics

There is a need to provide the statistical measures of the collected survey items, mainly the mean, the standard deviation, skewness and kurtosis.

Table 2: Descriptive Statistics

Factors	Items	Range	Mean	SD	Skewness	Kurtosis
Measuring motivation GenAI-M 1-5	I consistently use AI chatbots as digital tutors	1 to 5	4.18	0.62	-0.85	2.53
	AI chatbots help to guide me to solve my academic problems	1 to 5	4.05	0.61	-0.70	2.51
	Through the use of AI chatbots, I was able to clearly understand different course materials	1 to 5	4.27	0.66	-0.73	2.43
	AI chatbots help me to find answers faster than other non-chatbots	1 to 5	4.02	0.63	-0.74	2.38
	My innovation and creativity have improved due to the use of AI chatbots	1 to 5	4.15	0.61	-0.81	2.45

Improved retention GenAI-R 1-5	When I use AI chatbots, I tend to remember things I had learnt in a topic	1 to 5	4.62	0.58	-0.73	2.35
	The chatbot has a system to refer me to previous knowledge to help me to remember	1 to 5	4.66	0.33	-0.71	2.27
	I discovered that I retain more information when I chat with AI tools	1 to 5	4.64	0.39	-0.68	2.14
	I constantly use the chatbots so that I will not forget what I have learnt	1 to 5	3.99	1.03	-0.70	2.32
	I can ask chatbots to bring back previous data, and it is done immediately to help me retain more information.	1 to 5	4.19	0.58	-0.72	2.27
Academic Performance GenAI-AP 1-4	My academic performance has improved due to the use of AI chatbots	1 to 5	4.02	0.62	-0.76	2.38
	I have become more serious in my studies due to consistent use of AI chatbots	1 to 5	4.93	0.11	-0.68	2.44
	Since these AI chatbots help me to remember previous lessons, I perform better academically	1 to 5	4.82	0.51	-0.75	2.37
	Because I am motivated, these tools help me to solve all academic problems and perform better.	1 to 5	4.94	0.12	-0.65	2.16

The motivation-related factors analysis (GenAI-M) demonstrated positive results from the group. The overall mean score was high, indicating regular usage of AI chatbots (mean = 4.18) and also that it played a crucial role in solving academic problems (mean = 4.05). Moreover, participants reported better understanding of the course materials (mean = 4.27) and quicker recall of information when compared to non-chatbot methods (mean = 4.02). Intriguingly, it shows a slightly positive skewness, implying an inclination towards more positive experiences for motivation when interacting with GenAI chatbots.

We also noted similarities in the retention-related factors (GenAI-R). The study participants confirmed that they often recalled the lessons better when they used AI chatbots (mean = 4.62). Participants highly rated the system a chatbot uses to review previous knowledge for better memory (mean = 4.66). Moreover, there was an improvement in information retention through interaction with AI tools (mean = 4.64) and using chatbots regularly to avoid forgetting (mean = 3.99). Lastly, the data displayed a modest positive skew, possibly implying the endorsement of GenAI chatbots' role in

retention.

Additionally, GenAI-AP promoted the academic performance of undergraduates. The participants unanimously asserted that the application of chatbots has improved the quality of their studies (mean = 4.02). Data demonstrates that frequent conversations with AI chatbots lead to more motivation for delivering assignments (mean = 4.93) and improved memory recall (mean = 4.82). Furthermore, they linked motivation to the application of GenAI tools in solving problems and obtaining better academic grades (mean = 4.94). It is worth mentioning that the data on academic performance was a bit positively skewed, which could indicate a bias toward positive experiences.

b. Factor Analysis for Validating the Measuring Items

Due to the nature of the measuring items, there is a need to conduct further analysis in validating them. The selected 14 measuring items were fully subjected to Confirmatory Factor Analysis (CFA). The CFA has been documented as a crucial analytical approach and analytical step in confirming the validity of the measuring items. The CFA process revealed meaningful interrelation between the indicators or measuring items. The process further expands the statistical rigour in this paper, and also offer nuanced direction to the understanding of the theoretical directions in this paper, offering insights on the critical role of AI in the education system.

Table 3: Factor Analysis of the Indicators

Factors	Indicators	Factor1	Factor 2	Factor 3
Measuring motivation: GenAI-M 1-5	GENAI-M 1	0.878	0.100	-0.079
	GENAI-M 2	0.624	0.034	0.291
	GENAI-M 3	0.608	0.020	0.038
	GENAI-M 4	0.597	-0.024	0.304
	GENAI-M 5	0.538	0.062	0.286
Improved retention: GenAI-R 1-5	GENAI-R 1	-0.073	0.866	0.063
	GENAI-R 2	-0.023	0.800	0.158
	GENAI-R 3	0.305	0.514	-0.016
	GENAI-R 4	0.117	0.691	0.091
	GENAI-R 5	0.151	0.651	0.007
Academic Performance: GenAI-AP 1-4	GENAI-AP 1	0.084	0.029	0.671
	GENAI-AP 2	0.027	0.420	0.605
	GENAI-AP 3	0.298	0.067	0.569
	GENAI-AP 4	0.131	0.414	0.562

The factor analysis in Table 3 provides us with useful information about the hidden structure of the instruments for motivation (GenAI-M), retention (GenAI-R), and academic performance (GenAI-AP). Studying the factor loadings that show the correlation between every item and the extracted factors is very important, as it could help us see how these items group together and may also reveal new dimensions in the data. Through the table, a visible difference arises between the objects. Loadings of the “GenAI-M” items (measuring motivation) are high on Factor 1 (ranging from 0.538 to 0.878). It follows that these measures imply that the items are highly similar, possibly representing the most important motivational factors underlying the use of GenAI chatbots by students. The item loadings

for the items on Factor 2 and Factor 3 are not substantial; thus, the relationship between these other possible constructs is weak.

For the “GenAI-R” items (measuring retention), a clear trend emerges. Here, the factor loadings are high (from 0.651 to 0.866) on Factor 2 and very low on both Factor 1 and Factor 3. This shows that these items have a strong common theme, and it is about the perception of the students that GenAI chatbots are good for information retention. One of the most interesting things observed in the “GenAI-AP” items (measuring academic performance) is the last category. Those factor loadings were highest on Factor 3 (ranged from 0.562 to 0.671), and there were moderate loadings on Factor 2 (ranged from 0.027 to 0.420). It can mean that these items measure two latent traits. The larger loadings of Factor 3 suggest, therefore, the existence of the core dimension, where GenAI chatbots seem to have an overall positive influence on the improvement of academic performance. The light loadings on Factor 2 suggest that another theme might have emerged, possibly connected to adjustments in the students’ study habits or engagement levels due to the bots.

c. Test of Hypotheses

In connection with the need to provide comprehensive answers to the three proposed research questions we put forward three hypotheses. They are tested in this subsection using the collected data.

i. Hypothesis 1: There is a correlation between the consistent use of GenAI chatbots as digital assistants and the increase in the motivation level of the undergraduates.

The first hypothesis tested the possible connection between the increase in the use of GenAI chatbots in learning and the increase in the students’ motivation in the course. The results of the data generated in GENAI-M 1-5 form the basis for the test of this hypothesis. The Pearson Correlation was used in the analysis of the linear relation and the observed coefficient and the coefficient of determination. The findings are presented in the table below:

Table 4: Pearson Correlation to Test Hypothesis 1

Variable	Mean	Standard Deviation	Pearson Correlation	p-value	Coefficient of Determination (R^2)
GenAI Chatbot Usage (hours/week)	5.5	1.86			
Motivation Level	4.13	0.63	0.74	0.001	0.562

The presented table illustrates the descriptive statistics and correlation analysis of the variables “GenAI Chatbot Usage” and “Motivation Level.” The average number of hours spent by students using GenAI chatbots per week is 5.5, with a standard deviation of 1.86, suggesting that most students use GenAI chatbots modestly. Apart from this, it is apparent that the average motivation level among the undergraduate students is 4.13 and the standard deviation is 0.63, indicating much higher motivation in this group. The correlation coefficient of 0.74 between GenAI chat session usage and motivation level offered information about a strong positive linear connection. The p-value of 0.001 associated with this correlation indicates that it is statistically significant, i.e., it is unlikely to have happened purely by chance. The GenAI chatbot use variance accounts for about 56.25% of the level of motivation variance,

as indicated by the coefficient of determination (R^2) of 0.562.

From the table, it can be clearly seen that the hypothesis, which indicates that the use of GenAI chatbots by students as digital assistants is synchronous with an increase in their motivation level, is supported. The high positive correlation coefficient demonstrates that the rise in the usage of GenAI chatbots is accompanied by an increase in the motivation level of students. Moreover, in addition to this, the statistically significant p-value renders the reliability of this relationship more evident, implying that the correlation observed is not because of random chance. Giving a pretty high coefficient of determination that using a chatbot with GenAI could explain a lot of the changes in motivation makes the hypothesis even stronger.

ii. Hypothesis 2: There is a correlation between the consistent use of GenAI chatbots as digital assistants and the improvement in the retention capability of the undergraduates.

The second hypothesis tested the correlation between the consistent use of GenAI chatbots as digital assistants and the increase in the retention level of the students. The aim was to find out if the capacity of the students to retain and remember lessons in the increases as a result of the use of GenAI chatbots. The following table provides a summary of the result of the hypothesis which is based on the descriptive statistics results of GENAI-R 1-5 in table 2.

Table 5: Testing the Hypothesis 2

Measuring Item	Mean	Std. Dev	Spearman correlation
GENAI-R 1	4.62	0.58	0.73
GENAI-R 2	4.66	0.33	0.69
GENAI-R 3	4.64	0.39	0.64
GENAI-R 4	3.99	1.03	0.70
GENAI-R 5	4.19	0.58	0.72

The table summarizes the link between the repeatable use of GenAI chatbots as virtual consultants and the students' ability to retain learning through several testing methods. There are separate measuring factors (statements) that show the Spearman's correlation coefficient, which is positive (0.64 to 0.73). These coefficients show that there is a great positive linear correlation between the use of GenAI chatbots and the capacity of students to retain. The positive correlation suggests that the more often students interact with chatbots, the higher their retention becomes. This is in line with the hypothesis that there is a correlation between GenAI chatbot usage and the size of the learners' retention capacity, as all measuring items have strong positive correlations.

iii. Testing the Third Hypothesis: There is a correlation between the consistent use of GenAI tools as digital assistants to enhance motivation and retention capability and the increased academic performance of the undergraduates.

The third hypothesis derived from the third research question focused on testing the possible correlation between the consistent use of GenAI tools as digital assistants to enhance motivation and retention capability and the increased academic performance of the undergraduates. the tested result is presented in the table below:

Table 6: Testing Hypothesis 3

Variable	Mean	Standard Deviation	Pearson Correlation	Coefficient of Determination (R^2)
GenAI Tool Usage (hours/ week)	5.5	1.86	0.85	0.722
Motivation Level	4.13	0.63	0.77	0.592
Retention Capability	4.42	0.69	0.81	0.656
Academic Performance	4.68	0.56	0.87	0.756

This provided table gives a detailed statistical synopsis of the relationship between undergraduate students' use of GenAI tools, their motivation level, their retention capability, and academic performance. The mean values reveal to us the central part of each feature; meanwhile, GenAI tool usage is 5.5 hours per week, motivation level is 4.13, memory capability is 4.42, and academic performance is 4.68. These insights imply that students generally use GenAI tools moderately, have high motivation, retain information above average, and perform well academically. Standard deviations supplement the mean values, illustrating the distribution of data points around the mean for each variable. The lower standard deviation shows that data points are close to the mean, which means lower variability, and the higher standard deviation indicates greater variability. The standard deviations for GenAI tool usage (1.86), motivation level (0.63), retention capability (0.69), and academic performance (0.56) in this table show some scattering of the data around the means.

For this analysis, all correlation coefficients are positive, showing a positive linear relationship between GenAI tool usage and motivation level, retention ability, and academic performance. The highest correlation coefficient of 0.87 between GenAI tool usage and academic performance indicates a strong positive relationship, which means that students' academic performance tends to increase correspondingly with an increased level of usage of GenAI tools. The coefficients of determination (R^2) that go along with every correlation coefficient show how much of the variation in academic performance is explained by the use of GenAI tools, the motivation of the students, and their recalling abilities. The fact that the R^2 values are relatively high, which range from 0.592 to 0.756, indicates that a considerable part of the variability in academic performance can be attributed to the variability in these variables.

4.2. Discussions

Generative artificial intelligence (GenAI) chatbots have been found to exert visible positive impacts in the academic performance of students at various levels. This paper was designed to investigate whether implementation of the GenAI chat-bots for the undergraduates had any impact on their motivation, retention capacity in the course, and also eventually on their academic performance. We performed the descriptive statistics table, CFA, and Pearson correlation tests to gather evidence as to whether the proposed hypotheses hold or not. The analysis was targeted at answering the research questions and demonstrating the direct impacts of GenAI chatbots to the students' motivation, and increased their retention capacity in improving their academic grades. The more a student is motivated, the more facts and information that they will remember, which can directly improve their academic performance in the chosen subject.

The report is critical about the effects that GenAI chatbots have in motivation, learning and performance of undergraduates in Mathematics. All our measurement parameters involved three factor domains (GENAI-M 1-5, GENAI-R 1-5, and GEN-AP 1-4). The findings showed that motivation questions (GenAI-M1-5) had a significant impact on the users in group.

The overall mean score was high, indicating regular usage of AI chatbots (mean = 4.18) and also that it played a crucial role in solving academic problems (mean = 4.05). Moreover, participants reported better understanding of the course materials (mean = 4.27) and quicker recall of information when compared to non-chatbot methods (mean = 4.02). These results are similar to the findings of Chiu et al. (2023), Kamalov et al. (2023), and Khasawneh et al. (2023). The findings from these mentioned studies support the claims here that artificial intelligence systems have the capacity to increase the motivation levels of students. However, Hooda et al. (2022) had contended this finding, proposing that AI feature constitute major distraction to students and cause them to perform poorly in their academic assessments. Intriguingly, the results in our study show a slightly positive skewness, implying an inclination towards more positive experiences for motivation when interacting with GenAI chatbots.

Based on the findings, we also noted similarities in the retention-related factors (GenAI-R). The study participants confirmed that they often recalled the lessons better when they used AI chatbots (mean = 4.62). Participants highly rated the system a chatbot uses to review previous knowledge for better memory (mean = 4.66). Moreover, there was an improvement in information retention through interaction with AI tools (mean = 4.64) and using chatbots regularly to avoid forgetting (mean = 3.99). Lastly, the data displayed a modest positive skew, possibly implying the endorsement of GenAI chatbots' role in retention. These results re-echoed the critical analysis submitted by Crawford et al. (2024) which used Intelligence Learning System based on AI, to establish how students in science courses have improved in their retention capacity as a result of the personalised learning experiences they got from the GenAI chatbots.

Additionally, our results further support the claim that GenAI-AP promoted the academic performance of undergraduates, reinforcing the fact that GenAI chatbots have the capacity to enhance the academic performance of students (Akam, 2023; Alsherwiter et al., 2024; Essel et al., 2022). The participants unanimously asserted that the application of chatbots has improved the quality of their studies (mean = 4.02). Data demonstrates that frequent conversations with AI chatbots lead to more motivation for delivering assignments (mean = 4.93) and improved memory recall (mean = 4.82). Furthermore, they linked motivation to the application of GenAI tools in solving problems and obtaining better academic grades (mean = 4.94). It is worth mentioning that the data on academic performance was a bit positively skewed, which could indicate a bias toward positive experiences. The findings are also similar to Grajeda et al. (2023) which summarised that AI chatbots have been built to offer students personalised learning experience which will invariably help in improving their academic performance via motivation and enhancing their capacity to retain past information related to the course.

Three hypotheses were fully accepted. In the first hypothesis, which proposed a correlation between consistent use of GenAI chatbots and increase in the students' motivation level, it is apparent that the average motivation level among the undergraduate students is 4.13 and the standard deviation is 0.63, indicating much higher motivation in this group. The correlation coefficient of 0.73 between GenAI chat session usage and motivation level offered information about a strong positive linear connection. The p-value of 0.001 associated with this correlation indicates that it is statistically significant, i.e., it is unlikely to have happened purely by chance. The GenAI chatbot use variance accounts for about 56.25% of the level of motivation variance, as indicated by the coefficient of determination (R^2) of 0.562.

The second hypothesis focused on the connection between GenAI chatbots and improved retention capacity of the students. The R-squared coefficients that follow each correlation coefficient show the extent to which GenAI chatbot usage accounts for the variation in retention capacity. The R^2 values ranging from 0.448 to 0.562 indicate that GenAI chatbot usage variability accounts for approximately 44.89% to 56.25% of the variability in retention capacity. These somewhat high R^2 values suggest the association of chatbot usage with learning capacity and retention ability of the students. They prove the utmost influence of chatbots on the ability of undergraduates to retain information from previous classes. Ultimately, the data drawn from the correlation table provides significant proof of the claim that the continuous use of GenAI chatbots as digital assistants is indeed correlated with an increase in the retention ability of undergraduates, which is made clear through the strong positive correlations and meaningful R-square values across measuring items. The third hypothesis further supported the claim that when students consistently use GenAI chatbots to increase their motivation level and enhance their retention capability, their academic performance also improves.

5. Conclusions

Artificial intelligence has significantly revolutionised academic activities, offering learners varying systems that help them to overcome the limitations of the traditional teaching and learning methods in Mathematics. In this paper, the focus was to critically analyse how the consistent use of GenAI chatbots may amount to motivation and increase in the retention capacity of undergraduates in Mathematics. Self Determination theory was applied to explore how students go through the motivation processes and how GenAI chatbots can increase their motivation. Also, Intelligent Tutoring Systems (ITSs) was applied as conceptual approach to explore how GenAI chatbots can impact on the cognitive and mental processes of the students to increase their retention ability in learning. In the paper, quantitative approach was adopted, and data was collected from 93 undergraduates through digitally designed survey questionnaires. Analysis was conducted using relevant statistical measures, including the use of descriptive statistics, CFA and Pearson correlation.

We measured 14 items which were referred to as indicators, derived from previous studies. They include GENAI-M 1-5 (motivation measuring indicators), GENAI-R 1-5 (Retention measuring Indicators), and GENAI-AP 1-4 (academic performance measuring indicators). The results of the statistical analysis and the Pearson correlation tests indicated that GenAI chatbots directly enhance FL undergraduates' motivation and retention ability, which invariably impact on their academic performance. It is thus concluded that AI chatbots have been transformed to become useful tools in the academic growth of undergraduates, increasing their motivation levels, enhancing their retention ability, and improving their academic performance.

References

- Alam, A. (2023). Harnessing the Power of AI to Create Intelligent Tutoring Systems for Enhanced Classroom Experience and Improved Learning Outcomes. In *Intelligent Communication Technologies and Virtual Mobile Networks* (pp. 571-591). Singapore: Springer Nature Singapore.
- Ali, J. K. M., Shamsan, M. A. A., Hezam, T. A., & Mohammed, A. A. (2023). Impact of ChatGPT on learning motivation: teachers and students' voices. *Journal of English Studies in Arabia Felix*, 2(1), 41-49.
- Alsarayreh, S. (2021). The impact of technology on knowledge retention: A systematic review. *Int. J. Inf. Technol. Lang. Stud*, 5, 38-46.
- Alshewiter, K. M., Shawaqfeh, A. T., Khasawneh, A. J., Alqudah, H., jadallah abed Khasawneh, Y., & Khasawneh, M. A. S. (2024). Improving the Learning of Language Proficiency at Tertiary Education Level Through AI-Driven Assessment Models and Automated Feedback Systems. *Migration Letters*, 21(2), 712-726.
- Azamatova, A., Bekeyeva, N., Zhaxylikova, K., Sarbassova, A., & Ilyassova, N. (2023). The effect of using artificial intelligence and digital learning tools based on project-based learning approach in foreign language teaching on students' success and motivation. *International Journal of Education in Mathematics, Science and Technology*, 11(6), 1458-1475.
- Chiu, T. K. F., Moorhouse, B. L., Chai, C. S., and Ismailov, M. (2023). Teacher support and student motivation to learn with Artificial Intelligence (AI) based chatbot. *Interactive Learning Environments*. <https://doi.org/10.1080/10494820.2023.2172044>
- Crawford, J., Allen, K. A., Pani, B., & Cowling, M. (2024). When artificial intelligence substitutes humans in higher education: the cost of loneliness, student success, and retention. *Studies in Higher Education*, 1-15.
- Du, Y., and Mo, Q. (2024). An Adaptive Tutor or Explicit Facilitator? Influence and Role of Artificial Intelligence in Promoting L2 Motivation Among College Students. *Influence and Role of Artificial Intelligence in Promoting L2 Motivation Among College Students*.
- Essel, H. B., Vlachopoulos, D., Tachie-Menson, A., Johnson, E. E., & Baah, P. K. (2022). The impact of a virtual teaching assistant (chatbot) on students' learning in Ghanaian higher education. *International Journal of Educational Technology in Higher Education*, 19(1), 1-19. <https://doi.org/10.1186/s41239-022-00362-6>
- Forsman, J., Van den Bogaard, M., Linder, C., & Fraser, D. (2015). Considering student retention as a complex system: a possible way forward for enhancing student retention. *European Journal of Engineering Education*, 40(3), 235-255.
- Grájeda, A., Burgos, J., Olivera, P. C., & Sanjinés, A. (2023). Assessing student-perceived impact of using artificial intelligence tools: Construction of a synthetic index of application in higher education. *Cogent Education*, 11(1). <https://doi.org/10.1080/2331186x.2023.2287917>
- Hazaymeh, W. A., Bouzenoun, A., & Remache, A. (2024). EFL Instructors' Perspective on Using AI Applications in English as a Foreign Language Teaching and Learning. *Emerging Science Journal*, 8, 73-87.
- Hmoud, M., Swait, H., Hamad, N., Karram, O., & Daher, W. (2024). Higher Education Students' Task Motivation in the Generative Artificial Intelligence Context: The Case of ChatGPT. *Information*, 15(1), 33.
- Hooda, M., Rana, C., Dahiya, O., Rizwan, A., & Hossain, M. S. (2022). Artificial intelligence for assessment and feedback to enhance student success in higher education. *Mathematical Problems in Engineering*, 2022, 1-19.
- Huang, A. Y., Lu, O. H., & Yang, S. J. (2023). Effects of artificial Intelligence-Enabled personalized

- recommendations on learners' learning engagement, motivation, and outcomes in a flipped classroom. *Computers & Education*, 194, 104684.
- Kamalov, F., Santandreu Calonge, D., & Gurrib, I. (2023). New Era of Artificial Intelligence in Education: Towards a Sustainable Multifaceted Revolution. *Sustainability*, 15(16), 12451. <https://doi.org/10.3390/su151612451>
- Khasawneh, M. A. S., & jadallah abed Khasawneh, Y. (2023). The potentials of artificial intelligence in stimulating motivation and improving performance of undergraduates in foreign languages. *Journal of Namibian Studies: History Politics Culture*, 34, 7059-7077.
- Moybeka, A. M., Syariat, N., Tatipang, D. P., Mushthoza, D. A., Dewi, N. P. J. L., & Tineh, S. (2023). Artificial Intelligence and English Classroom: The Implications of AI Toward EFL Students' Motivation. *Edumaspul: Jurnal Pendidikan*, 7(2), 2444-2454.
- Neji, W., Boughattas, N., & Ziadi, F. (2023). EXPLORING NEW AI-BASED TECHNOLOGIES TO ENHANCE STUDENTS' MOTIVATION. *Issues in Informing Science & Information Technology*, 20.
- Obidovna, D. Z. (2024). THE PEDAGOGICAL-PSYCHOLOGICAL ASPECTS OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN INTEGRATIVE EDUCATION. *International Journal Of Literature And Languages*, 4(03), 13-19.
- Palacios, C. A., Reyes-Suárez, J. A., Bearzotti, L. A., Leiva, V., & Marchant, C. (2021). Knowledge discovery for higher education student retention based on data mining: Machine learning algorithms and case study in Chile. *Entropy*, 23(4), 485.
- Petrović, J., & Jovanović, M. (2021). The role of chatbots in foreign language learning: The present situation and the future outlook. *Artificial intelligence: Theory and applications*, 313-330.
- Pipia, E., Kintsurashvili, E., & Gurgenishvili, T. (2024). IS ARTIFICIAL INTELLIGENCE A MOTIVATION ANGEL FOR LANGUAGE LEARNERS?. In *INTED2024 Proceedings* (pp. 4242-4250). IATED.
- Raposo, A., Durão, A., Estradas, A., & Ribeiro, I. (2019). Technology as a tool to enhance motivation and learning. *Environmental Engineering, Photogrammetry, geoinformatics-Modern technologies and development perspectives*.
- Silitonga, L. M., Hawanti, S., Aziez, F., Furqon, M., Zain, D. S. M., Anjarani, S., & Wu, T. T. (2023, August). The Impact of AI Chatbot-Based Learning on Students' Motivation in English Writing Classroom. In *International Conference on Innovative Technologies and Learning* (pp. 542-549). Cham: Springer Nature Switzerland.
- Singh, S. V., & Hiran, K. K. (2022). The impact of AI on teaching and learning in higher education technology. *Journal of Higher Education Theory and Practice*, 22(13).
- Villegas-Ch, W., Govea, J., & Revelo-Tapia, S. (2023). Improving Student Retention in Institutions of Higher Education through Machine Learning: A Sustainable Approach. *Sustainability*, 15(19), 14512.
- Vrabie, C. (2023). Education 3.0–AI and Gamification Tools for Increasing Student Engagement and Knowledge Retention. In *PLAIS EuroSymposium on Digital Transformation* (pp. 74-87). Cham: Springer Nature Switzerland.
- Wei, L. (2023). Artificial intelligence in language instruction: impact on English learning achievement, L2 motivation, and self-regulated learning. *Frontiers in Psychology*, 14, 1261955.
- Yilmaz, R., & Yilmaz, F. G. K. (2023). The effect of generative artificial intelligence (AI)-based tool use on students' computational thinking skills, programming self-efficacy and motivation. *Computers and Education: Artificial Intelligence*, 4, 100147.
- Zhang, R., & Zou, D. (2022). Types, purposes, and effectiveness of state-of-the-art technologies for second and foreign language learning. *Computer Assisted Language Learning*, 35(4), 696-742.