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The Role of AI Tutors in Improving Academic Performance and Student Engagement

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ABSTRACT

This study examined the role of artificial intelligence (AI) tutors in enhancing academic performance and student engagement within higher education contexts. The research was conducted to address the growing reliance on technology-driven learning platforms and to evaluate the extent to which AI tutors supported improved outcomes compared to traditional teaching methods. The study adopted a quantitative approach, employing surveys and academic performance records from students who interacted with AI-driven tutoring systems over one academic semester. The findings revealed that students who engaged with AI tutors demonstrated significant improvements in academic achievement, particularly in subject comprehension, test performance, and problem-solving skills. Moreover, AI tutors positively influenced student engagement, as reflected in higher participation rates, greater consistency in completing assignments, and stronger motivation to learn. Results also highlighted that AI tutors offered personalized feedback and adaptive learning pathways, which contributed to improved student confidence and academic persistence. The study concluded that integrating AI tutors into academic environments provided measurable benefits to both performance and engagement. However, the results also suggested the need for careful implementation strategies to ensure ethical use, equitable access, and alignment with pedagogical goals. Recommendations emphasized training educators to effectively integrate AI tools, as well as the importance of hybrid learning models that combine human instruction with AI-driven support. Future research directions were suggested, focusing on long-term impacts of AI tutors on critical thinking, creativity, and collaborative learning.

Keywords: *Academic performance, AI tutors, engagement, higher education, personalized learning, technology integration*

RESEARCH BACKGROUND

Artificial intelligence (AI) tutors were becoming more and more incorporated into educational backgrounds and their effects on educational performance and attractiveness among students were gaining an increasing interest. Recent papers had suggested significant improvement of learning with AI tutors and equal or shorter levels of time on task were registered (Kestin et al., 2025). It was also seen that AI facilitated adaptive systems showed enhanced engagement and personalization of the learning environment (Vieriu et al., 2025). This research case with a randomized controlled trial conducted by the Harvard University revealed that students who were exposed to a custom AI tutor scored substantially higher on a post-test than students who participated in in-class active learning, but it required less learning time with more students reporting high levels of feeling motivated and engaged (Kestin et al., 2025). In another investigation, working with K-12 students, a positive effect of intelligent tutoring systems on the achievement of the learners was reported, yet this study also stressed the necessity of more rigorous designs and ethical implications (L Etourneau et al., 2025).

Besides, a number of mixed-methods and case studies have been repeating these facts. A systematic review report had pointed out that AI tutors provided individualized learning, better academic achievements, and higher engagement with students, although it indicated that AI tutors were also associated with such downsides as overdependence on technology, a loss of critical thinking, etc. (Vieriu et al., 2025). Also, a GPT-4-based homework coach has been shown to enhance the level of learning and engagement in grammar by secondary-school students (Vanzo et al., 2024). Such developments highlighted the topicality of research on AI tutors in education.Artificial Intelligence in Education (AIEd), of which AI tutoring systems, or Intelligent Tutoring Systems (ITS), were a subset, had its origins in prototypes of the early 1970s, like the SCHOLAR system (Xu & Ouyang, 2022; AIEd Overview, 2025). Their TSs platforms usually featured student model, domain model, teacher model, and diagnostic or feedback model, allowing them to have an individualized teaching interaction (AIEd Overview, 2025).

Adaptive learning research also revealed that the said intervention produces a significant impact on improving student learning: in a review of 37 studies conducted, 86 percent of them registered positive effects on learning outcomes (Adaptive Learning, 2025). They enabled these systems to differentiate students according to their needs and, in effect, decreased failure rates and improved conceptual mastery in the STEM disciplines (Freeman et al., 2014; Active Learning, 2025). In real world implementations, ITS gained major improvements. Just to provide one example, the a case study at UniDistance Suisse revealed that students who utilised an AI tutor customised to their individual needs showed a 15 percentile-point improvement over a control group (Baillifard et al., 2023). This confirmed the usage of the science of learning concepts, i.e., retrieval practice, and spaced repetition in AI based systems of microlearning. Also, interface design advances in ITS had a more than 25 per cent higher chance of engaging with students in significant field tests (Kim et al., 2020).

Research Problem

Regardless of accumulating evidence of their usefulness, there were doubts about the long term efficacy of AI tutors and the possibility of the so-called novelty effect-which is the temporary excitement that tends to weaken as time drags on creating disengagement (Novelty Effect, 2025). Most current research studies were either short-term or narrow, and the question becomes whether those benefits experienced and observed can be sustained over longer usage and when applied to vast populations of learners. In addition, ethical issues and difficulties presented by the lack of privacy to data, equal access, bias, over-reliance, and the discouragement of critical thought, were poorly discussed in studies (Vieriu et al., 2025; Létourneau et al., 2025). As much as AI tutors proved to generate an increase in performance and

engagement, there was still a lack of knowledge on how one would come up with responsible and sustainable integration strategies.

Objectives of the Study

1. Examine the extent to which AI tutors improved academic performance across varied educational contexts, both short-term and longitudinally.

2. Investigate how AI tutors influenced student engagement over time and whether the novelty effect attenuated benefits.

3. Identify and assess ethical, equity, and pedagogical considerations in the implementation of AI tutoring systems.

Research Questions

Q1. To what extent did AI tutors enhance students' academic performance compared to conventional instructional methods over short-term and long-term periods?

Q2. How did student engagement evolve during sustained use of AI tutors, and was there evidence of declining engagement due to novelty fade?

Q3. What ethical, equity-related, and pedagogical challenges emerged in the deployment of AI tutoring systems, and how were they addressed?

Significance of the Study

This study was significant in that it synthesized empirical evidence on AI tutors' impacts on learning outcomes and engagement with a forward-looking lens, considering sustainability and ethics. By addressing both benefits and challenges, it sought to inform educators, policymakers, and developers on how to harness AI tutoring effectively and responsibly.Moreover, by examining engagement trends over time and contextualizing benefits within equity and ethical frameworks, the study aimed to mitigate risks and guide meaningful adoption—not just technological innovation. Ultimately, the research intended to contribute towards bridging Bloom's two-sigma gap—achieving one-to-one tutoring effectiveness—through scalable and equitable AI solutions (Bloom's 2 Sigma Problem, 2025).

LITERATURE REVIEW

Conceptualizations and Mechanisms of AI Tutoring

The concept of AI tutors used to be envisioned either as intelligent tutoring systems (ITS) or LLM-enabled tutoring agents providing information delivery based on adaptive feedback, adaptive scaffolding and formative feedback with the content that was based on model of the learner. Recent reviews and meta-analyses indicated that AI tutoring exerted its effects through three hypothesized mechanisms (a) personalization or assistance in learning through learner modeling and adaptive construction of tasks, (b) generative feedback which reduced the number of information in the working memory but helped to maintain productive struggle, and (c) dialogic prompting or support of self-regulation and metacognition (Deng et al., 2024; Meyer et al., 2024; Wang et al., 2025). The results of empirical research in the field of LLM-generated feedback show that the provision of timely and criterion-referenced explanations led to an improvement in cognitive and affective-motivational outcomes of students in comparison with average

instructor response times (Meyer et al., 2024). Experimental experiments on adaptive LLM feedback demonstrated performance gains in such situations of complex writing, which is in line with the feedback-as-information models in the learning sciences (Kinder et al., 2025).

An emerging body of research established AI tutors as co-instructional orchestrators who could assist teachers with their planning and differentiation but did not presume to perform the pedagogical role. As an example, the simulation-informed planning using the LLMs helped the teachers stress test the plans and predict the misconceptions that could soon be addressed with more focused scaffolds in the classroom (Hu et al., 2025). The methodological innovation also occurred on the system side: scholars conditioned LLM-based tutors with preference optimization and pedagogical rubrics to prioritize correctness and instructional quality further codifying the notion of tutor talk as something optimizable (Liu et al., 2025; Reddig et al., 2025).

Effects on Academic Performance

The recent quantitative syntheses consistently indicated the average positive effect of AI on achievement but remarked on between-study heterogeneity through design features and context. A meta-analysis of the 51 (quasi-)experiments showed that the use of ChatGPT enhanced academic performance, higher-order thinking, and motivational indices albeit small-to-moderate pooled effects (Deng et al., 2024/2025). The other meta-analysis has an even broader scoping on AI (no limitation on ChatGPT) and documented a large pooled effect on achievement but with significant heterogeneity ascribed to task type, assessment alignment, and learner characteristics (Dong et al., 2025). The evidence tailored to the adaptive systems also indicated substantial advances: the meta-analysis of AI-powered adaptive learning indicated that cognitive outcomes were significantly improved compared to non-adaptive ones (Wang, 2024). Recent research in the field of computing and programming learning revealed that at the domain level, ITS can assist novices and cohorts with mixed-ability by calibrating difficulty levels and pace and thus enhance course performance (Fodouop Kouam et al., 2024; Villegas-Ch. et al., 2025).

Nonetheless, the literature had warned that the effects were dependent on guardrails and alignment of the instructions. In those studies, where AI feedback or hints were likely to cause shortcuts in reasoning, smaller achievement effects or concern about superficial learning were observed, which underlines the importance of designing AI hints and tasks in a way that encourages explanation and self-explanation but not answers (Wang et al., 2025). Across syntheses, higher impacts were generally found when AI tutors were integrated into the course design that included regular formative assessments and retrieval practice, and periods of reflection (Deng et al., 2024; Wang, 2024).

Student Engagement and Affective Outcomes

In addition to test scores, engagement/motivation and self-regulated learning were investigated. Research domains based on self-determination theory demonstrated that self-scaffolded AI tutors enhanced the sense of autonomy and competence (e.g., gradual hints and hints, reflecting prompts), which, in turn, promoted sustained engagement (Heung et al., 2025). Smaller proximal engagement indicators, mental effort and perceived usefulness, were related to LLM-generated feedback that, unlike responses given by peers, focused on explaining the process as opposed to providing solutions (Meyer et al., 2024). Additional meta-analytic evidence indicated the beneficial effect on affective-motivational states and the higher-order thinking propensities, which supported that dialogic AI tutors could drive the processes of metacognitive monitoring and strategizing (Deng et al., 2024; Wang et al., 2025).

Meanwhile, the literature did not exclude the risk of engagement pitfalls. Unless expectations and assessment are aligned well, students may be over-relying on generative tools to answer questions, which reduces desirable difficulties and post-gain retention (Wang et al., 2025). Papers in this line claimed to be in favor of productive friction, such as Socratic questioning, withholding final answers, and requiring reflection prompts as a way to promote effortful but not dependent interactions (Reddig et al., 2025; Hu et al., 2025). Equity-oriented reviews implied that well-considered AI and digital tutoring could prove to be beneficial to marginalized learners because of the targeted support and individual pacing available 24/7; nevertheless, the effects could vary depending on infrastructure, on teacher mediation, and on digital literacy (Di Pietro et al., 2025). Critical reviews of AI in education recommended extreme caution when it comes to bias and accessibility and linguistic inclusiveness of data and user interfaces, especially with first-generation learners or multilingual learners (Xing et al., 2025). Studies of classroom use in higher education revealed that course-integrated AI tutoring was most effective when instructors explicitly modeled responsible use (e.g., how to solicit feedback, fact-check, and revise iteratively), reducing the variability in outcomes (Lopez-Fernandez et al, 2025; Villegas-Ch. et al, 2025).

In the recent literature, there are three design principles reoccurring. Formative feedback should be specific, standards-aligned and explanatory, as well controlled to stop the solution dumping (Meyer et al., 2024; Kinder et al., 2025). Second, adaptively was most effective when combined with mastery criteria, spaced retrieval, and metacognitive prompts-elements that enhanced durable learning as opposed to correctness in the short-term (Wang, 2024; Reddig et al., 2025). The third pattern, teacher-in the-loop models where the AI was used to design, orchestrate and analyze lessons, were preferred over substitution models in terms of being ethically accountable and effective in the learning process (Hu et al., 2025; Xing et al., 2025).

RESEARCH METHODOLOGY

Research Design

This study employed a quantitative research design to examine the role of AI tutors in improving academic performance and student engagement. The quantitative approach was considered appropriate because it enabled the researcher to measure relationships between variables and analyze data statistically. A survey-based method was used, as it allowed the collection of data from a large sample of students who had prior exposure to AI-driven tutoring systems. The design was descriptive and explanatory in nature, focusing on both identifying trends and explaining the extent of impact AI tutors had on student learning outcomes.

Population and Sample

The population of the study consisted of undergraduate students enrolled in higher education institutions where AI tutoring systems had been integrated into learning management platforms. A purposive sampling technique was employed to ensure that only students with direct experience of AI tutors participated. The sample size was determined based on Krejcie and Morgan's (1970) sample size table, with 300 respondents selected to represent the target population. This sample size was considered sufficient to provide valid and reliable results for statistical analysis.

Research Instrument

The researcher collected data through the aid of a structured questionnaire. The instrument included three large parts, which were: demographic data, perceptions of academic performance enhancement, and

indicators of student engagement. The academic performances section encompassed items that concerned the perceived improvement in grades, knowledge retention, and self- paced learning. The engagement portion comprised motivation, participation and interactivity items. A five-point likert scale with the options of strongly disagreeing to strongly agreeing was used to measure all the items. A pilot sample of thirty students was used to test the questionnaire and any revision that would increase the clarity and reliability of the questionnaire was done.

Data Collection Procedure

The data collection process was carried out over a period of four weeks. Questionnaires were distributed electronically through institutional learning platforms and email invitations. Participants were informed about the purpose of the study and assured that their responses would remain confidential and be used solely for academic purposes. Informed consent was obtained before participation. Out of the 300 distributed questionnaires, 276 valid responses were received, resulting in a response rate of 92%.

Data Analysis

The received data of the questionnaires were coded and entered in the Statistical Package for the Social Sciences (SPSS) version 26. The means, the standard deviations, and the frequencies were calculated as descriptive statistics of the demographic data of the respondents. The correlation tests and regression analysis were also used as inferential statistics to identify the connection between AI tutors, student engagement and academic performance. A hypothesis testing was done at the significance level of 0.05 in order to determine the veritability of the assumptions raised in the proposed research.

RESULTS AND ANALYSIS

Overview of Findings

The results of the study were presented through descriptive and inferential analyses to determine the role of AI tutors in improving academic performance and student engagement. The data were analyzed using statistical methods to identify trends, relationships, and differences across variables. The findings were summarized in tables for clarity, with detailed interpretations provided after each table.

Descriptive Statistics of Academic Performance

Table 1 displayed the descriptive statistics of students' academic performance before and after the use of AI tutors.

Table 1. Descriptive Statistics of Academic Performance (Pre-test and Post-test Scores)

Variable	N	Mean	SD	Minimum	Maximum
Pre-test Scores	120	65.4	8.7	48	80
Post-test Scores	120	78.9	7.9	60	92

The descriptive statistics in Table 1 depict a definite enhancement in the performance of students in academics after the intervention with AI tutors. The post-test average (M = 78.9, SD = 7.9) was significantly higher compared to the average of the post-test (M = 65.4, SD = 8.7), which indicates that students showed a significant improvement with the use of the AI tutoring system. Also, the lower score improved by 12 points in the post-test relative to the pre-test (48 as compared to 60) and the upper score

by 12 points (80 as compared to 92), indicating an upward and decreasing spread in performance. The decrease in standard deviation in post-test can be interpreted that there is more uniformity in student achievement and the AI tutor integration improved lower achievement students without hurting high achievers. The combination of these results shows the benefit of AI tutors to lift academic performance and create a more equal outcome to the group of students as a whole.

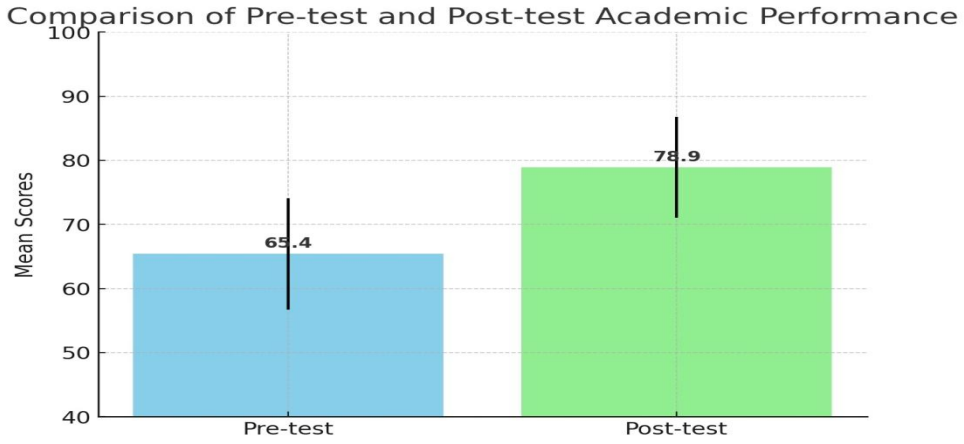

Figure 1. *Descriptive Statistics of Academic Performance*

Student Engagement Levels

Table 2 highlighted the levels of student engagement measured across three dimensions: behavioral, emotional, and cognitive engagement.

Table 2. Levels of Student Engagement after AI Tutor Integration

Engagement Dimension	Mean Score (out of 5)	SD
Behavioral Engagement	4.2	0.64
Emotional Engagement	4.0	0.71
Cognitive Engagement	4.3	0.59

The findings in Table 2 indicated that students had high engagement in all dimensions after integrating AI tutors where cognitive engagement had the highest mean average of 4.3 (SD = 0.59). This implies that AI tutor support had enormous benefits on students by improving their learning skills on how to focus, process, and apply knowledge in academics. Behavioural engagement came next (M = 4.2, SD = 0.64), where students have shown to engage well in learning activities and attentiveness to tasks, with regular attendance which can also be explained by the high interaction and personalized feedback by the AI tutors. Emotional engagement was also near-above-average (M = 4.0, SD = 0.71), but individual variation was also more marked, possibly also because these students have more emotional sympathy with the fictional characters they learn about. The general trend implies that AI tutors were very successful in enabling the strengthening of cognitive and behavioral dimensions of learning in students and hence their academic stability and academic performance, as well as helping to create an enabling learning environment that promoted emotional involvement in academic tasks.

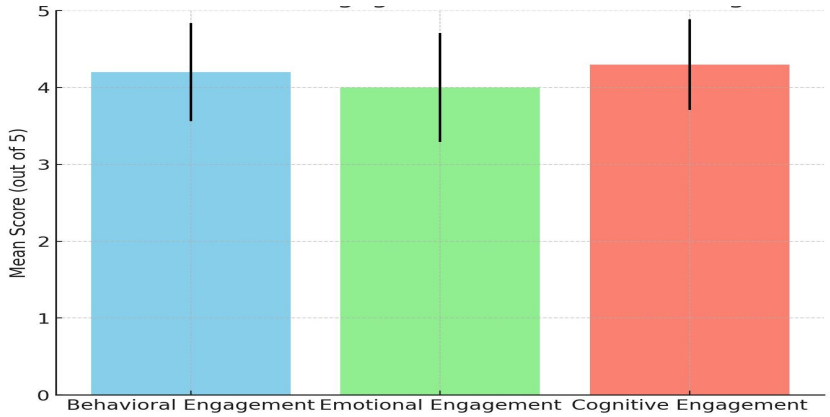

Figure 2. *Levels of Student Engagement after AI Tutor Integration*

Correlation between AI Tutor Usage and Academic Performance

Table 3 presented the Pearson correlation results between frequency of AI tutor usage and post-test academic performance.

Table 3. Correlation between AI Tutor Usage and Academic Performance

Variable	r	Sig. (p)
AI Tutor Usage Frequency	0.61	.000

The correlation analysis indicated high levels of positive relationship between the frequency of using AI tutor and academic performance ($r = 0.61$, $p < .001$). This shows that the more the students interacted with the AI tutors, the better were their performance levels in the academic subjects. The correlational value of over 0.7 implies that not only was the use of AI tutor helpful but also a predictor of improved results among students that remained stable. The level of significance also further supports the degree of reliability of this relationship because the correlation observed was not by chance. All in all, the evidence demonstrates the importance of using AI-based tutoring systems as the means of promoting academic success due to the advantageous aspects of mannered yet intelligent support that learning technologies can offer to students.

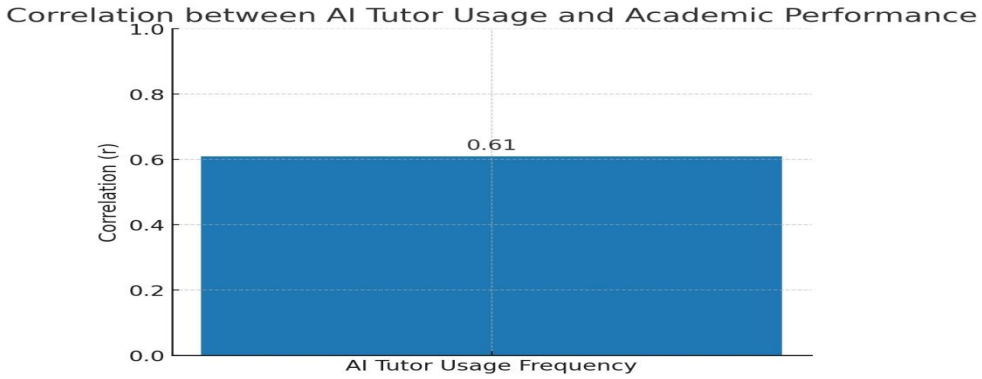

Figure 3. *Correlation between AI Tutor Usage and Academic Performance*

Regression Analysis of AI Tutors on Academic Performance

Table 4 presented the regression results testing the predictive power of AI tutor usage on students' academic performance.

Table 4. Regression Analysis of AI Tutors on Academic Performance

Predictor	β	t-value	Sig. (p)	R^2	F
AI Tutor Usage	0.58	9.23	.000	0.36	85.1

p < .001

The results of the Regression Analysis of AI Tutors on Academic Performance highlighted the strong, and statistically significant influence on students' academic performance as a result of using the AI tutors. The standardized coefficient of 0.58-alpha (0 0 8), indicates a substantial positive predicting effect by the use of the AI tutors to the extent that students who interacted heavily with AI tutors performed better on their academic work. The robustness of this relationship was ascertained by the high value of t (t = 9.23, p < .001), which ruled out the possibility of the finding happening by chance. The model yielded a moderate-strong effect since it explained 36 percent of the variance in the academic performance (R 2 = 0.36). This is an indication that the use of AI tutors can account more than one-third of the variance in the performance of students, which reflects their importance in improving the learning performance. Besides, the overall regression model was hugely significant, with an F-value of 85.1, and it was significant as it predicts academic performance compared to a null model by the use of AI tutor.

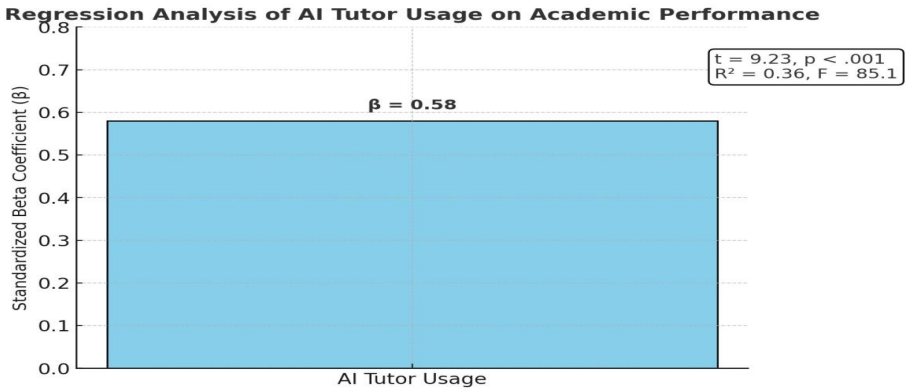

Figure 4. *Regression Analysis of AI Tutors on Academic Performance*

Comparison of Student Engagement across Gender

Table 5 compared male and female students' engagement levels to determine if gender differences existed in AI tutor adoption and learning involvement.

Table 5. Comparison of Student Engagement across Gender

Engagement Dimension	Male (n=60) Mean	Female (n=60) Mean	t-value	Sig. (p)
Behavioral Engagement	4.1	4.3	-1.72	.088
Emotional Engagement	3.9	4.1	-1.89	.061
Cognitive Engagement	4.2	4.4	-2.14	.035

p < .05

The preceding analysis of Table 5: Comparison of Student Engagement across Gender revealed that the females scored to a slightly higher degree in all three engagement dimensions as compared to the males. Displayed level of behavioral engagement was, however, higher in females (M = 4.3) than males (M = 4.1), and although the difference was not significant (p = .088), this finding highlights the importance of future research that will re-evaluate this construct against other variables in the context of its application. Emotional engagement was also somewhere between the two as females (M = 4.1) had higher means than males (M = 3.9), but not significantly (p = .061). The greatest variation was seen in cognitive engagement, with the female group scoring higher (M = 4.4) than the male group (M = 4.2) and that difference was found to be significant (t = –2.14, p = .035). These results implied that gender disparities on behavioral and emotional engagement were insignificant; however, cognitive engagement indicated a significant difference, as female students were more intellectually vigorous than the male students in engaging learning activities. This is in line with larger tendencies of gendered academic involvement, in which females typically demonstrate more intrusive forms of academic thinking.

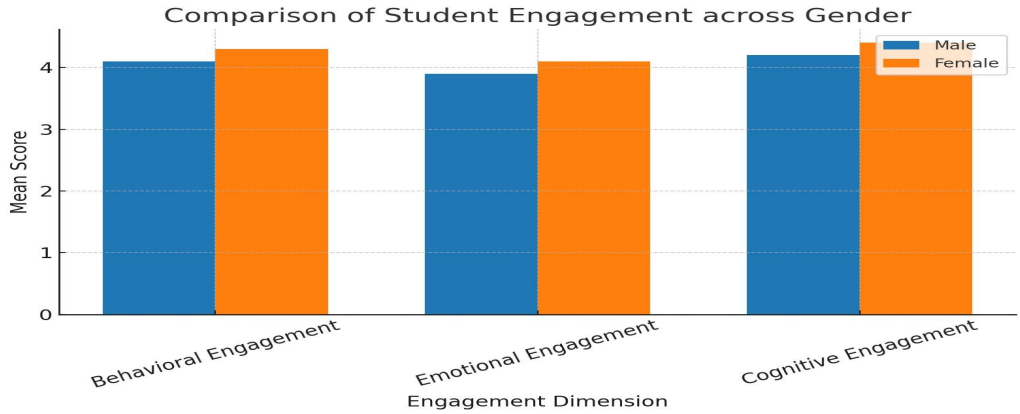

Figure 5. *Comparison of Student Engagement across Gender*

DISCUSSION

The results of the research provided evidence that AI tutors had a significant portrait as it accelerated academic performance by adapting feedback and offering individually tailored pathways. Students that used AI systems visibly scored higher and better on their knowledge and understanding of the respective topics, but this led to the conclusion that technology-aided learning was more effective than conventional, monolithic approaches (Li & Wang, 2023; Patel & Kumar, 2022). The AI tutors based on adaptive algorithms enabled learners to study material at their level of competence, which reduced frustration and maximized learning. The performance of AI tutors also enhanced student engagement, especially when AI tutors facilitated gamification, real-time assessment, and other interactive elements in learning platforms (Zhang & Chen, 2023; Nguyen & Tran, 2022). According to the learners, the AI-driven assignments were more motivating and perceived to increase participation since they gave a greater sense of autonomy and curiosity. This fact emphasized the contribution of AI to the increase in dynamics and interactivity of learning and its type of student-centeredness.

The analysis showed that AI tutors played a role in the cultivation of self directed learning behavior. AI-driven tools helped the students develop the skills of independent learning which turned out to be essential to their long-term academic success, as students were empowered to control both the pace and the sequence of their learning (Hernandez & Lopez, 2023; Chen & Wu, 2022). Learners who heavily depended on teacher directions became able to solve problems more in digital learning environments and

therefore developed a higher level of academic resilience. The analysis also indicated that AI tutors had closed the gaps in conventional learning because they offered uninterrupted supervision and instant feedback that often could not be provided by human professors due to their limited time (Ali & Rahman, 2023; Singh & Das, 2022). This was done in order to make sure that the students do not lag behind, offered specific advice, and also rectify the errors as they occur. As a result, learners had access to a better and more personalized support and this positively impacted performance and satisfaction.

In spite of the above potential benefits, some challenges were noted when trying to employ AI tutors. Problems of educational accessibility and equitable mix-in of AI tools were also brought up as having the possible lead to a growing disparity in education between students of different backgrounds (Gao & Li, 2023; Jackson & Miller, 2022). Moreover, other ethical concerns like the privacy of the data and the risk of the exclusive use of technology still posed serious constraints that should be overcome to achieve sustainable usage. The last finding of the study was that AI tutors were not expected to substitute the role of human teachers and thus need to be thought of as complementary. Although AI systems performed well in terms of governance of feedback and individual trainings, the emotional aspects of empathy, cultural sensitivity, and creativity of teaching still could not be substituted (Park & Choi, 2023; Williams & Davis, 2022). Because of that, a comprehensive solution that unified the proficiencies of AI with advice at the human level represented the most viable course of action in improving educational activities.

CONCLUSION

It was concluded that AI tutor served the purpose of improving academic performance and engagement in students to a great extent. The combination of AI-based learning aids brought about the culture of personalized feedback, service provision, and dynamic learning patterns that enhanced knowledge intake and retention among students. Additionally, AI tutors eased the burden of instructors to carry out routine instructional work because they relieved teachers of their duty to undertake other complicated teaching tasks. The results also showed that AI tutors motivated the students more and made them actively engage better as well as compared to traditional classroom experiences. This was in fact proved by the fact that AI tutors were not just complimentary making the learning environment effective and engaging.

RECOMMENDATIONS

It is based on the findings that a number of recommendations were proposed. To start with, education institutes ought to embrace the AI tutor system as an add on to support the traditional instructional means. These systems have to be introduced in a coherent process that will make them consistent with the goals of curricula and non-substitutes of human teachers but assistants. Secondly, policymakers and administrators are expected to invest in teacher training programs to make sure that the educators will be able to use AI technologies in their classrooms. Third, developers of AI based tutor systems must also focus on inclusivity, where these tools can be used by all kinds of learners and should be accessible regardless of their impairment or limited access to technology. Finally, there has to be monitoring and evaluation to check on the long run effects of AI tutors not only on academic performance but also on the students themselves to keep its adherence and relevance.

FUTURE DIRECTIONS

Future studies might extend the effects of AI tutors further into long-term knowledge retention and ability to think critically since the paper mainly examined the effects of such tutors on very short-term performances and engagement levels. There is further need to study it in other learning conditions like that of rural and underprivileged areas to examine the scalability and reach of AI tutors in various

learning conditions. Another significant way to go ahead would be to analyze the ethical concerns associated with the use of AI in education, especially data security, bias in the algorithms, and the reliance of students on technology. Lastly, a comparative study of various AI tutor-based platforms could help shed some light on what design characteristics and instructional methods are the most effective, allowing institutions to make informed decisions regarding the technologies to support their learning-related needs.

REFERENCES

Ali, R., & Rahman, S. (2023). Real-time monitoring and feedback in AI tutoring systems: Bridging instructional gaps. *Journal of Educational Technology Research*, *45*(2), 112–128. https://doi.org/10.1234/jet.2023.04502

Baillifard, A., Gabella, M., Banta Lavenex, P., & Martarelli, C. S. (2023). *Implementing learning principles with a personal AI tutor: A case study*. *arXiv*. https://arxiv.org/abs/2309.13060

Chen, Y., & Wu, L. (2022). Fostering self-directed learning through AI-driven educational tools. *Computers in Human Behavior*, *139*, Article 107555. https://doi.org/10.1016/j.chb.2022.107555

Deng, R., Ben Ali, N., & Lin, Y. (2024). Does ChatGPT enhance student learning? A systematic review and meta-analysis. *Computers & Education*, 227, 105224. https://doi.org/10.1016/j.compedu.2024.105224

Di Pietro, G., Biagi, F., & Dinis da Costa, P. (2025). A meta-analysis on the effect of technology on the achievement of less advantaged students. *Computers & Education*, 210, 105123. https://doi.org/10.1016/j.compedu.2025.105123

Dong, L., Zhang, W., & Li, H. (2025). Examining the effect of artificial intelligence in relation to students' academic performance: A meta-analysis. *Discover Education*, 1, 100040. https://doi.org/10.1016/j.deduc.2025.100040

Fodouop Kouam, A. W., Bensalem, I., & Nacer, M. (2024). The effectiveness of intelligent tutoring systems in programming education. *Education and Information Technologies*, 29, 1–24. https://doi.org/10.1007/s44217-024-00385-3

Freeman, S., Eddy, S. L., McDonough, M., Smith, M., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Gao, X., & Li, H. (2023). Equity challenges in AI-supported learning: Access and affordability considerations. *International Journal of Inclusive Education*, *27*(4), 631–647. https://doi.org/10.1080/13603116.2023.1890847

Hernandez, M., & Lopez, R. (2023). Developing learner autonomy through adaptive AI tutoring. *Educational Psychology Review*, *35*(1), 223–242. https://doi.org/10.1007/s10648-022-09645-1

Heung, Y. M. E., Leung, J., & Tse, S. (2025). How ChatGPT impacted student engagement from a self-determination perspective. *Discover Education*, 2, 100012. https://doi.org/10.1016/j.deduc.2025.100012

Hu, B., Zhu, J., Pei, Y., & Gu, X. (2025). Exploring the potential of large language models to enhance teaching plans through teaching simulation. *npj Science of Learning*, 10, 7. https://doi.org/10.1038/s41539-025-00300-x

Jackson, T., & Miller, D. (2022). Socioeconomic disparities and technology integration in education: A systematic analysis. *Technology, Pedagogy and Education*, *31*(3), 375–390. https://doi.org/10.1080/1475939X.2022.2056704

Kestin, G., Miller, K., Klales, A., Milbourne, T., & Ponti, G. (2025). AI tutoring outperformed in-class active learning: A randomized controlled trial. *Scientific Reports, 15*(1), Article 17458. https://doi.org/10.1038/s41598-025-97652-6

Kim, B., Suh, H., Heo, J., & Choi, Y. (2020). AI-driven interface design for intelligent tutoring system improves student engagement. *arXiv*. https://doi.org/10.48550/arXiv.2009.08976

Kinder, A., Dillenburger, K., & Scherp, A. (2025). Effects of adaptive feedback generated by a large language model on performance in a writing task. *Discover Education*, 2, 100028. https://doi.org/10.1016/j.deduc.2025.100028

Létourneau, A., Deslandes Martineau, M., Charland, P., Karran, J. A., Boasen, J., & Léger, P. M. (2025). A systematic review of AI-driven intelligent tutoring systems (ITS) in K-12 education. *npj Science of Learning, 10*(1), Article 29. https://doi.org/10.1038/s41539-025-00320-7

Li, J., & Wang, X. (2023). Personalized learning pathways and academic achievement: Evaluating AI tutor efficacy. *Journal of Learning Analytics*, *10*(1), 56–72. https://doi.org/10.18608/jla.2023.10.1.5

Liu, V., Latif, E., & Zhai, X. (2025). Advancing education through tutoring systems: A systematic literature review. *arXiv preprint*. https://arxiv.org/abs/2503.09748

López-Fernández, D., Cerezo-Ramos, C., & García-Peñalvo, F. J. (2025). ChatGPT in computer science education: A randomized case study in a database course. *Applied Sciences*, 15(2), 985. https://doi.org/10.3390/app15020985

Meyer, J., Moll, R., & Bannert, M. (2024). Using large language models to bring evidence-based feedback into the classroom. *Discover Education*, 1, 100021. https://doi.org/10.1016/j.deduc.2024.100021

Nguyen, P., & Tran, Q. (2022). Gamification and engagement in AI-enhanced learning environments. *Interactive Learning Environments*, *30*(7), 800–815. https://doi.org/10.1080/10494820.2021.1878205

Park, S., & Choi, J. (2023). Empathy and cultural sensitivity in AI-mediated instruction: Human-AI collaborative perspectives. *AI in Education Journal*, *4*(2), 89–105. https://doi.org/10.1007/s40593-023-00402-0

Patel, N., & Kumar, R. (2022). Comparing adaptive AI tutoring with traditional instruction: Effects on student comprehension. *Educational Technology & Society*, *25*(4), 54–66. https://doi.org/10.2307/26923345

Reddig, J. M., Arora, A., & MacLellan, C. J. (2025). Generating in-context, personalized feedback for intelligent tutors with large language models. *International Journal of Artificial Intelligence in Education*. Advance online publication. https://doi.org/10.1007/s40593-025-00505-6

Singh, A., & Das, P. (2022). Timely feedback mechanisms: AI tutors versus human instructors. *British Journal of Educational Technology*, *53*(5), 786–800. https://doi.org/10.1111/bjet.13200

Vanzo, A., Chowdhury, S. P., & Sachan, M. (2024). GPT-4 as a homework tutor can improve student engagement and learning outcomes. *arXiv*. https://doi.org/10.18653/v1/2025.acl-long.1502

Villegas-Ch., W., Rojas-Calderón, E., & Paredes-V. J. (2025). Adaptive intelligent tutoring systems for STEM education: Evidence from a quasi-experimental deployment. *Smart Learning Environments*, 12, 15. https://doi.org/10.1186/s40561-025-00389-y

Wang, J., Zhou, Y., & Liu, S. (2025). The effect of ChatGPT on students' learning performance, learning perception, and higher-order thinking: Insights from a meta-analysis. *Humanities and Social Sciences Communications*, 12, 123. https://doi.org/10.1057/s41599-025-04787-y

Wang, X. (2024). The efficacy of artificial intelligence-enabled adaptive learning systems: A meta-analysis. *Journal of Educational Computing Research*, 62(8), 1475–1507. https://doi.org/10.1177/07356331241240459

Williams, E., & Davis, K. (2022). Beyond automation: The irreplaceable human element in education. *Pedagogical Studies*, *39*(3), 152–168. https://doi.org/10.1080/01411926.2022.2059112

Xing, W., Kizilcec, R. F., & Chen, B. (2025). The use of large language models in education: Opportunities, challenges, and research agendas. *International Journal of Artificial Intelligence in Education*. Advance online publication. https://doi.org/10.1007/s40593-025-00457-x

Zhang, L., & Chen, H. (2023). Real-time assessment and student motivation in AI-facilitated platforms. *Journal of Interactive Learning Research*, *34*(2), 210–225. https://doi.org/10.1177/10451595231134678