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Evaluating the Effectiveness of Generative AI in Improving Student Engagement and Learning Outcomes in Virtual Classrooms

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Abstract
This paper looks at how well generative artificial intelligence, especially large language models and AI content creators, can improve student participation and learning results in online classrooms. It uses existing data from systematic reviews, meta-analyses, policy reports, and studies published between 2020 and 2025. The study brings together evidence on how much students learn, how they feel about learning (like interest and engagement), and possible problems like depending too much on AI or cheating. The research method involves carefully looking at high-quality reviews and studies, pulling out summaries of how much each study found, and analyzing common ways AI helps learning, such as personalizing content, giving feedback, and supporting students. The results show that using AI in a smart way, with help from teachers, can lead to better learning and more engagement, but using it without thinking can make students less active in thinking and learning. The paper also talks about what schools and teachers should do, along with the study's limits and suggestions for future research.

Keywords: student engagement, learning outcomes, virtual classroom, secondary data, systematic synthesis

Introduction

Generative AI, or GenAI, refers to systems that can create text, images, and other types of content similar to what humans produce. It has quickly become part of educational environments, changing how students get explanations, practice skills, and receive feedback in online classes. Teachers and schools are using GenAI for tasks like tutoring, creating learning materials, giving feedback, and making classes more interactive. The fast spread of these tools brings up important questions: Do these tools help students get more involved and learn better? In what situations do they support learning, and when might they actually make it harder?

This paper looks at these questions by collecting and summarizing information from studies, reviews, and policy papers published between 2020 and 2025.

The goal is to evaluate how effective GenAI is in online learning environments and to offer useful advice for teachers and schools. Overall, the research suggests that GenAI tools can have a positive impact on student performance and engagement, but there are important factors to consider, especially when it comes to how they are used and how they affect honesty and integrity in education.

Research Objectives and Questions

Objectives

1. Collect and combine information from existing studies about how GenAI tools like ChatGPT, AI tutors, and content generators affect student participation in online classes.
2. Gather and combine evidence about how well students learn when using these tools.
3. Find out how these tools influence learning through factors like personalized learning, quick feedback, and structured support, and how things like teacher involvement, subject area, and student level affect their impact.
4. Provide real-world and policy-based suggestions for using GenAI tools in online education in a way that is both ethical and effective...

Research question

1 How much and in what direction does the use of GenAI impact student involvement in online classes, according to studies done by others?

2 How much and in what direction does the use of GenAI affect students' academic performance and their ability to think critically in online learning environments?

3 What factors and situations influence how much GenAI helps or hinders student engagement and learning results?

4 What are the main challenges and things schools need to think about before using GenAI?

3. Methodology (Secondary-Data Synthesis)

1. Selection criteria: We included studies that are peer-reviewed, such as systematic reviews, meta-analyses, and actual experiments. These studies were published between 2020 and 2025 and looked at how GenAI or similar AI tools, like tutoring systems or content generators, work in educational settings. These settings include elementary and high schools, colleges, and continuing education. The studies also looked at how these tools affect student engagement and learning results. We also included reports from well-known agencies to better understand the bigger picture.

2. Search strategy & sources: We searched various places, including academic databases, publisher websites, and reports from institutions. Some of the studies we found include Deng (2024), Monib (2024), the US Department of Education report (2023), and recent meta-analyses up to 2025. We focused on highly impactful summaries and peer-reviewed papers to analyse their findings and themes. All the specific sources used for the claims and research in this review are cited below and listed in the references

3. Data extraction: From each selected study, we gathered information on the type of study (like a meta-analysis, review, or experiment), the level of education (such as K–12, college, or continuing education), the type of AI intervention (like AI tutor or content generator), the outcome measures (such as grades, test scores, engagement levels, and time spent on tasks), the reported results (like effect sizes or written summaries), and any factors that might influence the outcomes (such as teacher involvement, subject area, or prior skills).

4. Synthesis: We described and compared the quantitative findings from meta-analyses. When different studies showed different results, we used thematic analysis to explore why differences

happened. heterogeneity (integration method, human mediation). Qualitative studies and policy reports were used to triangulate and interpret findings.

Limitations of method: Since it's secondary, this kind of research relies on the quality and amount of information already written about the topic. It can be limited because new studies take time to come out, reports might be different from each other, and people might use the word "engagement" in various ways. This type of research can't take the place of direct experiments, but it can help spot clear trends and show where more research is needed.

Review of Literature (ROL) Expanded (author, year)

This ROL offers a broader look at important reviews and research results, highlighting both positive support and warnings from the evidence.

1. Systematic reviews & meta-analyses

• **Deng (2024)** did a thorough review of how educational tools are used and found that using ChatGPT led to better academic results, improved attitudes and motivation, and better thinking skills. However, the results varied depending on the type of tasks and how support was given. The overall findings suggested that using ChatGPT as a helper rather than a full substitute for main learning activities had positive short-term effects on performance.

• **Wang (2025**) looked at many studies on generative models and found that they generally helped learning and how students felt about it.

But the results were different based on the quality of the studies and the situation they were in. Wang also pointed out that when teachers helped guide the use of these tools, the results were better than when students used them on their own.

• **Monib (2024)** focused on generative AI and connected it to theories like self-regulated learning and cognitive load theory.

The review showed that generative AI can support independence and interest in learning, especially with fast, personalized help. But if used too much, it might reduce the mental effort needed for deep understanding

2. Empirical studies and syntheses

- **U.S. Department of Education (2023):** A report was published that discussed how AI can help reduce the amount of routine work teachers have to do, give ongoing feedback to students, and tailor learning experiences to individual needs. However, the report also warned about unequal access to AI tools and the importance of training teachers and creating strong ways to assess student learning. The report suggested testing AI tools carefully and using them to support, rather than replace, teaching.

  • **Abbas (2024**) looked into whether ChatGPT helps or hurts learning and found that in some cases, it can lead to students depending too much on it, delaying work, and remembering less information. Abbas suggested that teachers need to design lessons carefully to keep students actively thinking and involved**.**

• **A recent study from Frontiers in Education (Granström et al., 2025)** showed that students are widely using generative AI for explanations and draft work. However, they also expressed concerns about trust and academic honesty**.**

3. Mechanisms reported in literature

• **Personalization & scaffolding:** Many studies say that improvements come from personalized explanations, adjusted difficulty levels, and fast feedback (Monib, 2024; Deng, 2024). These features help save time and make learning feel more useful.

• **Feedback quality & revision cycles:** Feedback from AI that helps with repeated improvements makes learning more engaging, especially in writing and language learning (Wang, 2025).

• **Risk of lowered cognitive engagement:** Some lab tests and early reports suggest that depending too much on AI for answers may reduce deep thinking, creativity, or critical thinking if students just accept AI results without questioning them (Abbas, 2024; Time/MIT reporting).

Secondary Data Analysis & Findings

Below we bring together the key quantitative results from major reviews and selected research studies. Since we are using existing research (reviews and meta-analyses), our "analysis" includes comparing the size of effects and looking at common themes.

1. Summaries of effect sizes (from meta-analyses and reviews)

Deng (2024): Found that ChatGPT-style interventions generally had a positive impact on academic performance and emotional outcomes across different studies.

The size of these effects varied depending on the study design and were usually small to moderate in studies that didn't control for other factors

Wang (2025) looked at 51 studies and found that overall, using AI had a positive effect on how well people learn. When teachers were involved in guiding the use of AI, the results were even better.

Monib (2024) found that the impact of GenAI depends on the situation.

It helps a lot when it's used to support learning and provide feedback.

Overall, even though the exact numbers vary between studies because they looked at different things, there's a clear trend: when teachers plan and guide the use of AI, it leads to better learning and more engagement.

But if students use AI on their own without help, the results are less clear and there's a bigger chance it might not help them think deeply about what they're learning.

2. Thematic findings on engagement

• **More time spent on tasks and feeling more involved**: Many studies show that when students get personalized and repeated feedback from AI, they tend to practice more and spend more time on their tasks (as found in Deng 2024 and Monib 2024).

• **Interest and emotional response:** AI tools that make feedback fun or offer instant support can increase students' interest, especially in language learning and practice settings.

But how much this helps depends on how trustworthy and fair students think the AI is**.**

3. Risks and negative outcomes

• **Too much reliance and less thinking:** Research (Abbas 2024; recent lab studies) shows that using GenAI without structure can lead to shallow understanding and less deep learning. This problem gets worse when tests only check the final result and not how the work was done.

• **Problems with honesty in school:** When lots of students use AI tools, it becomes harder to tell what is original work and who did it.

Schools are being told to change how they test students. (This is also mentioned in education policies, US Department of Education, 2023.)

Discussion

1. Synthesis of evidence

Secondary evidence suggests that generative AI can have a positive impact on learning results and student involvement in online classes, but this effect depends on how it is used. The best results happen when AI tools are used as part of teaching methods, with clear instructions, regular feedback, and support from teachers. However, if students use AI without guidance, it may not be as helpful and could even lead to problems like becoming too dependent on AI or not developing strong thinking skills

These findings are supported by multiple high-quality studies, including meta-analyses and systematic reviews, which generally show positive effects but also highlight that the impact varies depending on the situation and how the AI is implemented.

6.2 Practical implications for virtual classrooms

Focus on the process, not just the product: Assessments should look at the work students do, like writing drafts, keeping track of changes, and reflecting on their learning, so that using AI to fix mistakes doesn't hide a lack of real understanding.

• **Teachers should guide the use of AI:** Teachers should create clear questions, show how to carefully think about what AI says, and use AI as a tool to help learning, not as a substitute for real learning.

• **Teach students how to use AI wisely:** Students need help learning how to write good questions for AI, check if sources are reliable, and think critically about what AI produces.

• **Make sure everyone has fair access:** It's important to provide equal access to AI tools and make sure they don't make existing unfair differences worse.

6.3 Policy recommendations

- Try and check: Schools should test AI tools with clear goals and share the results of their tests.
- - Set rules for ethics and honesty: Make clear guidelines that show the difference between using AI properly and cheating.
- - Train teachers: Spend time teaching staff how to use AI in teaching and how to change their grading methods.

Limitations

• **Secondary-data dependence:** This paper uses existing research, so the conclusions depend on the quality, variety, and how recent the available studies are.

• **Heterogeneous interventions:** "Generative AI" includes many different tools like large language models, multimodal generators, and AI tutors, which are used in different fields. This makes it hard to measure overall effects without a specific meta-analysis.

• **Rapidly evolving field:** The world of Generative AI changes quickly, so new tools and teaching methods might affect results or best practices after the latest research included here.

Conclusion

Generative AI has potential to make learning more interesting and effective in online classes, but only if it's used carefully as part of a well-thought-out teaching plan. This plan should include support for students, regular feedback, and active guidance from teachers. However, there are risks like students becoming too dependent on AI, not thinking deeply about their learning, and issues with honesty. Schools need to change how they test students, offer training, and test new AI tools carefully. Future studies should use strict testing methods and track how much time students spend learning and how engaged they are to better understand how AI affects learning over time.

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