



AI-CHATGPT, STUDENTS' ENGAGEMENT AND PROBLEM-SOLVING ABILITY IN UNDERGRADUATE PHYSICS: AN EXPERIMENTAL STUDY

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Abstract:

The integration of Artificial Intelligence (AI) into science education can transform instructional methods by providing supporting, interactive and personalized learning experiences. This study examines the effects of AI-ChatGPT on students' engagement and problem-solving ability in physics at the undergraduate level. A quasi-experimental design was adopted, with a study sample of 115 physics students divided into an experimental group (ChatGPT-Integrated Instruction, CGPT-II) and a control group (Traditional Lecture Method, TLM). Data were collected using Pre-Engagement Scale, Post-Engagement Scale, Pre-Problem Solving Test, and Post-Problem-Solving Test, with reliability coefficient values, $\alpha = 0.76, 0.78, 0.79,$ and $0.81,$ respectively. Collected data were analyzed using descriptive, t-test and Analysis of Covariance (ANCOVA) statistics at a 0.05 significance level. Results showed that students exposed to CGPT-II demonstrated significantly higher engagement scores ($MS = 3.98, SD = 0.62$) compared to the control group ($MS = 2.77, SD = 1.06$) with a t-test value of $t(113) = 7.49, p < 0.05$. Similarly, the experimental group outperformed the control group in problem-solving ability ($MS = 71.61\%, SD = 6.80$) compared to the control group ($MS = 59.40\%, SD = 8.52$), yielding $t(113) = 8.52, p < 0.05$. ANCOVA analysis indicated a significant main effect of the teaching method on post-test engagement $\{F(1, 113) = 27.67, p < 0.001, \text{partial } \eta^2 = 0.20\}$ and problem-solving ability $\{F(1,112) = 69.48, p < 0.001, \text{partial } \eta^2 = 0.382\}$ scores between the experimental and control groups. These findings indicate that ChatGPT significantly enhanced both engagement (behavioral, emotional, and cognitive) and problem-solving ability of students in physics. It is therefore recommended that school authorities should organize training workshops and seminars for science lecturers on the use of AI-ChatGPT, and support them with the required facilities.

Keywords: ChatGPT, physics, engagement, problem-solving ability, artificial intelligence

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1. Introduction

Physics remains an integral scientific knowledge required for technological development in our world, yet it is still generally viewed as difficult and challenging due to its mathematical and abstract concepts content. This “difficult subject” view of physics bore out from students’ inability to understand its abstract concepts, apply formulae and relate theoretical concepts to real-life situations, consequently leading to poor motivation, disengagement and problem-solving difficulties among physics students. This suggests that students’ engagement and problem-solving ability remain central to effective physics learning and academic success.

In Physics learning, academic engagement is a vital factor to meaningful learning and quality academic outcomes because of the subject's nature. Students’ engagement refers to the extent of active participation in learning activities in a way that involves the whole self of the learner in terms of class concentration, curiosity, dedication, and determination displayed in learning tasks. Nesi *et al.* (2022) and Werth *et al.* (2022) define students’ engagement as the level of active involvement, motivation, and cognitive investment learners bring to physics learning. It is usually subdivided into: Behavioral, Emotional, and Cognitive engagement. Behavioral engagement deals with participation in learning tasks, attendance, persistence, positive conduct during instruction, time-on-task, taking part in labs or group work, and persistence through difficult tasks (Nesi *et al.*, 2022; Werth *et al.*, 2022; Burkholder *et al.*, 2020). Emotional engagement indicates the feelings, attitudes, and motivation students attach to physics learning, such as enjoyment, interest, or anxiety (Nesi *et al.*, 2022), as positive emotional engagement, like interest or enjoyment, correlates with deeper involvement and better learning disposition (Dou *et al.*, 2022; Nassiri *et al.*, 2025). Cognitive engagement implies the mental effort students invest in understanding, reflecting, conceptualizing, applying strategies, and solving problems, including sense-making, constructing mental models, evaluating reasoning, and using multiple representations (Nesi *et al.*, 2022; Sirnoorkar *et al.*, 2022; Gjerde *et al.*, 2022).

Problem-solving ability in Physics is a complex interplay of conceptual understanding and reasoning, mathematical skill, problem identification and representation, application of relevant principles, and logical deduction. According to Burkholder *et al.* (2020) and Gjerde *et al.* (2022), problem-solving ability refers to a student’s capacity to analyze a physical situation, identify relevant principles, develop a solution strategy, carry out computations or reasoning, represent results appropriately, and critically evaluate the solution. Simangunsong *et al.* (2024) define problem-solving in physics as a systematic process in which learners identify known and unknown variables, choose appropriate formulas or laws, and justify each step of their reasoning. When students are both cognitively and emotionally engaged, their problem-solving tends to be more persistent, creative, and accurate (Dou *et al.*, 2022; Gjerde *et al.*, 2022; Alanazi *et al.*, 2025). Thus, engagement increases conceptual understanding and improves

performance on tasks that require analytical thinking, which in turn, enhances problem-solving ability.

ChatGPT (Chat Generative Pre-Trained Transformer) is a generative artificial intelligence chatbot designed to interact with human users, understand natural-language prompts, answers varieties of questions, solve problems and produce human-like responses, such as explanations, creative writing, etc. These abilities to provide user-friendly responses and personalized feedbacks make it a potential in enhancing teaching-learning outcomes. Several scholars have claimed that ChatGPT has benefits and the ability to support students in a variety of teaching-learning situations (Boudouaia *et al.*, 2024; Gan *et al.*, 2024; Zhou & Kim, 2024; Hsu, 2024; Maurya, 2024; Nugroho *et al.*, 2023), significantly boosting productivity and creativity in academic and professional settings (Dwivedi *et al.*, 2023).

Students' engagement and problem-solving skills have been lacking for a while in science classrooms, leading to poor academic achievement. Research studies revealed that students continuously showed a lack of motivation, low participation and difficulties in applying scientific concepts to real-life problems (Fredricks *et al.*, 2016; Reeve & Cheon, 2021). Although AI tools can promote students' active participation and support higher-order thinking skills, research evidence on their real impact on student engagement and problem-solving skills in physics classrooms remains inconclusive (Ahmad *et al.*, 2022; Wang *et al.*, 2024). This, therefore, necessitates the need for this study, most especially knowing that the use of AI tools in Nigerian classrooms is still at an early stage and has not been fully applied in our teaching-learning system.

1.1 Objective of the Study

The main objective of this study is to investigate the effects of ChatGPT (as an AI tool) on students' engagement and problem-solving ability in physics at the undergraduate level.

1.2 Research Hypotheses

- 1) There is no significant difference in the academic engagement of physics students taught using ChatGPT-Integrated Instruction, CGPT-II (experimental group) and those taught using the Traditional Lecture Method, TLM (control group).
- 2) There is no significant difference in the problem-solving ability of physics students taught using ChatGPT-Integrated Instruction, CGPT-II (experimental group) and those taught using the Traditional Lecture Method, TLM (control group).

2. Literature Review

Research studies have shown students' engagement to be strongly influenced by the immediacy, personalization, and feedback mechanisms that ChatGPT provides (Tlili *et al.*, 2023; Montenegro-Rueda *et al.*, 2023). Studies by Kasneci *et al.* (2023) reported that students experience higher persistence because ChatGPT reduces frustration and encourages task continuation. Another research study also reported that ChatGPT

increases students' willingness to attempt challenging tasks by offering explanations, worked examples, hints, and instant feedback, and then persist through difficulty, thus increasing observable behavioral engagement (Shahzad *et al.*, 2024; Almogren *et al.*, 2024). Researches also reported that ChatGPT being able to provide novelty, ease of use, perceived usefulness, and fast feedback has helped to increase students' emotional engagement in terms of improving students' motivation, interest, curiosity and satisfaction with learning activities, especially in large classes where instructor feedback is scarce (Kim *et al.*, 2025; Chan & Hu, 2023; Kasneci *et al.*, 2023; Montenegro-Rueda *et al.*, 2023). Wu *et al.* (2023) in a quasi-experimental study using ChatGPT-ipads blended learning observed that students exposed to ChatGPT significantly outperformed those exposed to iPads in terms of intrinsic motivation, emotional engagement, and self-efficacy. Several other quasi-experimental, systematic reviews, and meta-analysis of empirical studies have reported the capabilities of ChatGPT to improve students' behavioral, emotional and cognitive engagement in various ways, such as accessibility of learning resources, providing personalized feedbacks, fostering autonomy and motivation, helping students gain deeper understanding of content knowledge, etc. (Anjarani *et al.*, 2024; Deep, 2025; Guo *et al.*, 2025; Heung & Chiu, 2025; Lo *et al.*, 2024; Shams *et al.*, 2025).

Some research studies has explored the use ChatGPT to facilitate the comprehension of complex knowledge concepts (Haindl & Weinberger, 2024; Zhou & Kim, 2024), solve complex problems (Küchemann *et al.*, 2023; Urban *et al.*, 2024), assist students in solving difficult problems (Bitzenbauer, 2023; Yang *et al.*, 2025), provide problem-solving solutions (Hamid *et al.*, 2023; Urban *et al.*, 2024; Yılmaz & Karaoğlan-Yılmaz, 2023), and collaborate with students to complete complex tasks (Darmawansah *et al.*, 2024; Urban *et al.*, 2024). Other studies have also observed that ChatGPT supports students in applying their knowledge to real-life situations and solving practical problems, improves problem-solving skills, increases self-efficacy, and supports stepwise debugging and solution refinement (Mai *et al.*, 2024; Yılmaz & Karaoğlan-Yılmaz, 2023). Studies by Song *et al.* (2025) reported that AI chatbots like ChatGPT significantly enhanced students' practical performance, increased their intention levels, and thus tackled the creative problem-solving task compared to engaging in discussions with their peers. Other studies have also shown that ChatGPT fosters critical, deeper and higher-order thinking (Jahic *et al.*, 2023; Montenegro-Rueda *et al.*, 2023; Lu *et al.*, 2024; Wang & Fan, 2025; Deng *et al.*, 2024).

However, other studies have argued that ChatGPT hinders students' learning performance, learning perception, and higher-order thinking (Hays *et al.*, 2024; Rahman & Watanobe, 2023), as well as their behavioral, cognitive, and emotional engagement depending on how it is integrated into learning (Záková *et al.*, 2025; Deng *et al.*, 2024). For example, Yang *et al.* (2025) in a quasi-experimental study showed that students exposed to ChatGPT had lower flow experience, self-efficacy, and learning performance compared to those exposed to the traditional method.

3. Methodology

This study employs a pretest-posttest quasi-experimental research method. The target population for the study includes all science students offering Physics courses in the School of Secondary Education (Sciences), Federal College of Education, Abeokuta, Ogun State, Nigeria. Through a random sampling technique, 200-level students ($N = 115$) offering Physics courses were selected as the sample size. The sample students were divided into experimental ($N = 57$) and control ($N = 58$) groups.

Pre-Engagement Scale (Pre-ES), Post-Engagement Scale (Post-ES), Pre-Problem Solving Test (Pre-PST), and Post-Problem Solving Test (Post-PST) were used as the study instruments. The Pre-ES and Post-ES are questionnaires containing 15 items each, developed by the researchers. The Pre-ES was designed as a pretest engagement to measure the students' academic engagement (behavioral, emotional and cognitive) in class due to the previous lectures received from lecturers prior to this study (which is generally based on the usual TLM), while the Post-ES was designed as a post-test engagement to measure the students' academic engagement (behavioral, emotional and cognitive) in class due to the conventional lecture, TLM and the experimental treatment, CGPT-II received from this current research study. Responses to the Pre-ES and Post-ES were based on four-point Likert scale of Strongly Agree ($SA = 4$), Agree ($A = 3$), Disagree ($D = 2$) and Strongly Disagree ($SD = 1$).

The Pre-PST and Post-PST are assessment tests containing 10 items each, developed by the researchers to measure the students' problem-solving ability in Physics. It is based on Bloom's higher-order taxonomy and contains both structured and open-ended questions that require application, analysis, and evaluation. The Pre-PST was designed as a problem-solving pretest to measure the students' problem-solving ability resulting from their previous lectures, which are generally based on the usual TLM, while the Post-PST was designed as a problem-solving post-test to measure the students' problem-solving ability that results from the conventional lecture and experiment treatment (TLM and CGPT-II) received from this current research study. Each item in the Pre-PST and Post-PST has a score of 5 marks, to make up a total score of 50 marks. The Pre-ES, Post-ES, Pre-PST and Post-PST were validated by expert colleagues in measurement and evaluation. The reliabilities of the instruments (Pre-ES, Post-ES, Pre-PST, and Post-PST) were determined using Cronbach's Alpha, yielding reliability coefficients of $\alpha = 0.76, 0.78, 0.79,$ and 0.81 , respectively.

The Pre-ES and Pre-PST were first administered to students in the two groups (experimental and control) as pretests to measure the students' entry academic engagement and problem-solving ability, and as well determine the equivalence of the two groups. Statistical analysis of the pretest scores indicated that there was no significant difference in the prior academic engagement and problem-solving ability of the students between the two groups. Thereafter, the experimental group ($N = 57$) was taught using ChatGPT-Integrated Instruction (CGPT-II), while the control group ($N = 58$) was taught using the Traditional Lecture Method (TLM). At the completion of the teaching-learning

activities, which covered four weeks each for both groups, a post-test measuring the students' academic engagement and problem-solving ability was administered to all students (experimental and control groups) using the Post-ES and Post-PST. The post-test was conducted under strict examination conditions in order to ensure maximum students' concentration and avoid cross-communication of ideas while responding to Post-ES and Post-PST. Collected data were analyzed using descriptive (mean, standard deviation), t-test and Analysis of Covariance (ANCOVA) statistics at 0.05 level of significance using SPSS statistical software.

4. Results and Discussion

4.1 Pretest Analysis and Test of Group Equivalence

Table 1: Academic engagement and problem-solving ability pretest scores and the t-test analysis result for students across the groups

Students' Academic Engagement							
Group	N	MS	SD	MSD	df	t-value	Sig. (2-tailed)
Experimental (CGPT-II)	57	2.72	1.53	0.18	113	0.616	0.541
Control (TLM)	58	2.54	1.61				
Students' Problem-Solving Ability							
Group	N	MS	SD	MSD	df	t-value	Sig. (2-tailed)
Experimental (CGPT-II)	57	59.51	8.47	0.21	113	0.133	0.902
Control (TLM)	58	59.30	8.55				

Note: MS = Mean Score, SD = Standard Deviation, MSD = Mean Score Difference.

Table 1 shows the pretest scores of students' academic engagement and problem-solving ability, together with the t-test results for both experimental and control groups. The table indicated a low engagement pretest mean score difference (MSD = 0.18) between the experimental group (M = 2.72, SD = 1.53) and the control group (M = 2.54, SD = 1.61). The independent samples t-test revealed no statistically significant difference $\{t(113) = 0.616, p = 0.541\}$ between the experimental and the control groups. As shown in the table, the problem-solving ability has a low pretest mean score difference (MSD = 0.21) between the experimental group (M = 59.51, SD = 8.47) and the control group (M = 59.30, SD = 8.55). The independent samples t-test revealed a t-test value of $t(113) = 0.133, p = 0.902$, indicating that there is no statistically significant difference between the experimental and the control groups. These results confirmed that the pretest mean scores were similar across groups, thus indicating that the two groups are equivalent in terms of their academic engagement and problem-solving ability prior to this study.

4.2 Research Hypothesis 1

Ho1: There is no significant difference in the academic engagement of physics students taught using ChatGPT-Integrated Instruction, CGPT-II (experimental group) and those taught using the Traditional Lecture Method, TLM (control group).

Table 2a: Pretest, post-test and t-test analysis of academic engagement scores of physics students exposed to AII and TLM

Treatment		Students' Academic Engagement								
		Pretest Score			Posttest Score			T-test Analysis		
Group	N	MS	S.D	MSD	MS	S.D	MSD	df	t-value	p-value
CGPT-II	57	2.72	1.53	0.18	3.98	0.62	1.21	113	7.49	0.002
TLM	58	2.54	1.61		2.77	1.06				

Note: MS = Mean Score, SD = Standard Deviation, MSD = Mean Score Difference.

Table 2a revealed the analysis of academic engagement scores of students under CGPT-II and TLM instructions. As shown on the table, the physics students taught using CGPT-II had a higher post-test mean engagement score (MS = 3.98, SD = 0.62) than those taught using TLM (MS = 2.77, SD = 1.06), with a higher mean score difference (MSD = 1.21) compared to the pretest mean score difference (MSD = 0.18). The independent samples t-test analysis showed a t-test value, $t(113) = 7.49$, at a $p < 0.05$ level of significance. Hence, the null hypothesis is rejected. This implies that there is a statistically significant difference in the academic engagement of physics students taught using CGPT-II and those taught using the TLM. These results indicate that students in ChatGPT-supported classrooms showed higher participation in learning activities, involvement and possibly increased learning interest than their colleagues taught using the traditional method.

Table 2b: Summary of ANCOVA Analysis result for students' academic engagement under CGPT-II and TLM

Dependent Variable: Posttest Engagement						
Source	Type III Sum of Squares	df	Mean square	F	Sig	Partial Eta Squared
Corrected Model	21.63	2	10.82	14.94	0.000	0.21
Intercept	56.74	1	56.74	78.32	0.000	0.41
Pretest (Covariate)	2.31	1	2.31	3.19	0.077	0.03
Teaching Method (Independent Variable)	20.05	1	20.05	27.67	0.000	0.20
Error	81.89	113	0.724			
Total	1308.40	116				
Corrected Total	103.52	115				

Note: Independent variable: Teaching methods (CGPT-II, TLM), Covariate: pretest engagement score

Table 2b showed the results of the analysis of covariance (ANCOVA) conducted to examine the effect of the teaching methods (CGPT-II and TLM) on students' academic engagement in class. These results showed that there was a significant main effect of teaching methods on post-test engagement, $F(1, 113) = 27.67$, $p < 0.001$, partial $\eta^2 = 0.20$. This result indicates that approximately 20% of the variance in post-test engagement scores is due to the differences in the teaching methods. The pretest engagement (covariate) was not statistically significant, $F(1, 113) = 3.19$, $p = 0.077$, suggesting that the initial engagement scores did not strongly predict post-test engagement in this study. These results showed that ChatGPT-Integrated Instruction produced significantly higher

students' engagement than the traditional lecture method. This suggests that incorporating artificial intelligence tools into teaching-learning activities can foster meaningful students' involvement and participation in learning activities.

These study results are in line with previous research works of Anjarani *et al.* (2024), Deep (2025), Guo *et al.* (2025), Heung & Chiu (2025), Lo *et al.* (2024), Shams *et al.* (2025), among others. Anjarani *et al.* (2024) in their quasi-experimental study found that the use of ChatGPT significantly increased students' behavioral, cognitive, and emotional engagement in EFL writing classes compared to those under the traditional instruction, due to the real-time personalized feedback and interactive support. Deep (2025), during a systematic review on ESL higher education, found that ChatGPT fostered engagement by providing personalized feedback and accessible learning resources, which increased participation and interaction with content. Guo *et al.* (2025), during a longitudinal classroom study, showed that the use of ChatGPT enhanced students' motivation and engagement in learning activities over a prolonged period. Heung & Chiu (2025) conducted a meta-analysis of empirical studies and reported that ChatGPT-based learning is more effective than non-ChatGPT learning at fostering student's engagement (behavioral, cognitive, and emotional) across diverse educational settings. Lo *et al.* (2024), in a systematic review of some research studies, showed that ChatGPT-supported learning environments generally promote behavioral and cognitive engagement for students, including increased task completion, self-regulation, and depth of thinking. Shams *et al.* (2025) in an empirical study showed a positive association between ChatGPT usage and student's engagement, e-learning satisfaction, and performance in higher education.

4.3 Research Hypothesis 2

Ho2: There is no significant difference in the problem-solving ability of physics students taught using ChatGPT-Integrated Instruction, CGPT-II (experimental group) and those taught using the Traditional Lecture Method, TLM (control group).

Table 3a: Pretest, post-test and t-test analysis for problem-solving ability scores of physics students exposed to AI and TLM

Treatment		Students' Problem-Solving Ability								
		Pretest Score			Posttest Score			T-test Analysis		
Group	N	MS	S.D	MSD	MS	S.D	MSD	df	t-value	p-value
CGPT-II	57	59.51	8.47	0.21	71.61	6.80	12.21	113	8.50	0.002
TLM	58	59.30	8.55		59.40	8.52				

Note: MS = Mean Score, SD = Standard Deviation, MSD = Mean Score Difference.

Table 3a showed that physics students taught using CGPT-II had a higher post-test mean score (MS = 71.61%, SD = 6.80) in their problem-solving ability than those taught using TLM (MS = 59.40%, SD = 8.52), with a mean score difference, MSD = 12.21, compared to the pretest mean score difference (MSD = 0.21). The independent samples t-test analysis showed a t-test value, $t(113) = 8.50$, which is significant at the $p < 0.05$ level. This implies

that there is a statistically significant difference in the problem-solving ability of physics students taught using CGPT-II and those taught using the TLM. These results clearly showed that students in ChatGPT-supported classrooms demonstrated greater ability at problem-solving than their colleagues taught using the traditional lecture method.

Table 3b: Summary of ANCOVA Analysis result
 for students' problem-solving ability under AII and TLM

Dependent Variable: Posttest Problem-Solving Ability						
Source	Type III Sum of Squares	df	Mean square	F	Sig	Partial Eta Squared
Corrected Model	4031.22	2	2015.61	37.95	0.000	0.404
Intercept	569200.38	1	569200.38	10726.61	0.000	0.990
Pretest (Covariate)	272.41	1	272.41	5.13	0.025	0.044
Teaching Methods	3690.52	1	3690.52	69.48	0.000	0.382
Error	5946.83	112	53.09	—	—	—
Total	587588.00	115	—	—	—	—
Corrected Total	9978.05	114	—	—	—	—

Note: Independent variable: Teaching methods (CGPT-II, TLM), Covariate: pretest Problem-Solving score

Table 3b showed the results of ANCOVA analysis conducted to examine the effect of the teaching methods (AII and TLM) on students' problem-solving ability. These results revealed that there was a statistically significant difference in post-test problem-solving ability due to the teaching methods, $F(1,112) = 69.48$, $p < 0.001$, partial $\eta^2 = 0.382$. This shows that approximately 38.2% of the variance in students' problem-solving scores was due to the teaching method. The pretest problem-solving ability was also significant, $F(1,112) = 5.13$, $p = 0.025$. This suggests that the initial problem-solving ability contributed meaningfully to post-test problem-solving ability. These results showed that ChatGPT-Integrated Instruction is more effective than the Traditional Lecture Method in enhancing students' problem-solving ability.

These findings supported previous studies such as those of Deng *et al.* (2024), Urban *et al.* (2024), Wang & Fan (2025), Wu *et al.* (2024), and Yilmaz & Karaođlan-Yilmaz (2023), among others. Deng *et al.* (2024) and Wang & Fan (2025) in a meta-analysis study showed that the use of ChatGPT generally improves higher-order cognitive outcomes, including problem solving, critical thinking and academic performance, especially when students use it directly within scaffolding learning activities. Urban *et al.* (2024) in their experimental study observed that students using ChatGPT produced more original and better solutions on a complex creative problem task than those not using ChatGPT. Wu *et al.* (2024) in an experimental study showed that ChatGPT integration into learning enhance students' capacity to plan, monitor and complete problem-solving tasks through improved learners' self-regulated learning behaviors and knowledge construction. Yilmaz & Karaođlan-Yilmaz (2023) observed that generative AI in programming tasks improved students' computational problem-solving skills, increased self-efficacy, and supported stepwise debugging and solution refinement.

5. Conclusion

These results suggest that incorporating ChatGPT in the teaching-learning system has the potential to foster more active, motivated, and cognitively interested students, through improved students' participation, more time on task completion, completion motivation, ability to apply concepts, personalized feedback, enhanced curiosity and persistence in problem-solving compared to traditional instruction.

6. Recommendations

Based on the findings from this study, it is recommended that school authorities and other education stakeholders should (i) organize training workshops and seminars for science teachers on the use of ChatGPT in science teaching-learning processes, and (ii) support them with all necessary learning materials needed for effective implementation of ChatGPT and other AI tools in classrooms.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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References

- Ahmad, M., Zeshan, F., & Ali, S. (2022). Artificial intelligence in education: A review of current applications, challenges, and future directions. *Education and Information Technologies*, 27(3), 3171–3195. <https://doi.org/10.1007/s10639-021-10774-3>.
- Alanazi, A., Osman, K., & Halim, L. (2025). Enhancing physics problem-solving skills through guided discovery and scaffolding strategies. *LUMAT: International Journal on Math, Science and Technology Education*, 12(4), 5. <https://doi.org/10.31129/LUMAT.12.4.2329>.
- Almogren, A. S., Al-Rahmi, W. M., & Dahri, N. A. (2024). Acceptance of ChatGPT in higher education. *Heliyon*, 10. <https://doi.org/10.1016/j.heliyon.2024.e31887>.
- Anjarani, S., Furqon, M., & Rakhmawati, F. (2024). ChatGPT to foster students' engagement in writing class: An intervention study. *Veles: Journal of English Language Education*, 8(3), 630–640. <http://dx.doi.org/10.29408/veles.v8i3.27687>.
- Boudouaia, A., Mouas, S., & Kouider, B. (2024). A study on ChatGPT-4 as an innovative approach to enhancing English as a foreign language writing learning. *Journal of Educational Computing Research*. <https://doi.org/10.1177/07356331241247465>.
- Bitzenbauer, P. (2023). ChatGPT in physics education: a pilot study on easy-to-implement activities. *Contemp. Educ. Technol.*, 15(3). <https://doi.org/10.30935/cedtech/13176>.
- Burkholder, E. W., Miles, J. K., Layden, T. J., Wang, K. D., Fritz, A. V., & Wieman, C. E. (2020). Template for teaching and assessment of problem solving in introductory physics. *Physical Review Physics Education Research*, 16(1). <https://doi.org/10.1103/PhysRevPhysEducRes.16.010123>.
- Chan, C. K. Y., & Hu, W. (2023). Students' perceptions of generative AI. *International Journal of Educational Technology in Higher Education*, 20(1), 411. <https://doi.org/10.1186/s41239-023-00411-8>.
- Darmawansah, D., Rachman, D., Febiyani, F., & Hwang, G.-J. (2025). ChatGPT-supported collaborative argumentation: Integrating collaboration script and argument mapping to enhance EFL students' argumentation skills. *Education and Information Technologies*, 30(3), 3803–3827. <https://doi.org/10.1007/s10639-024-12986-4>.
- Deep, P. D., Martirosyan, N., Ghosh, N., & Rahaman, M. S. (2025). ChatGPT in ESL higher education: Enhancing writing, engagement, and learning outcomes. *Information*, 16(4), 316. <https://doi.org/10.3390/info16040316>.
- Deng, R., Jiang, M., Yu, X., Lu, Y., & Liu, S. (2024). Does ChatGPT enhance student learning? A systematic review and meta-analysis of experimental studies. *Computers & Education*, 227. <https://doi.org/10.1016/j.compedu.2024.105224>.
- Dou, R., Brewes, E., Potvin, G., Zwolak, J. P., & Hazari, Z. (2018). Understanding the development of interest and self-efficacy in active-learning undergraduate physics courses. *International Journal of Science Education*, 40(13), 1587–1605. <https://doi.org/10.1080/09500693.2018.1488088>.
- Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-

- Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., & Wright, R. (2023). Opinion paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, 71. <https://doi.org/10.1016/j.ijinfomgt.2023.102642>.
- Fredricks, J. A., Filsecker, M., & Lawson, M. A. (2016). Student engagement, context, and adjustment: Addressing definitional, measurement, and methodological issues. *Learning and Instruction*, 43, 1–4. <https://doi.org/10.1016/j.learninstruc.2016.02.002>.
- Gan, W., Ouyang, J., Li, H., Xue, Z., Zhang, Y., Dong, Q., Huang, J., Zheng, X., & Zhang, Y. (2024). Integrating ChatGPT in orthopedic education for medical undergraduates: Randomized controlled trial. *J. Med Internet. Res.*, 26. <https://doi.org/10.2196/57037>.
- Gjerde, V., Paulsen, V. H., Holst, B., & Kolstø, S. D. (2022). Problem solving in basic physics: Effective self-explanations based on four elements with support from retrieval practice. *Physical Review Physics Education Research*, 18(1). <https://doi.org/10.1103/PhysRevPhysEducRes.18.010136>.
- Guo, Y., Li, X., & Cunningham, G. (2025). One year in the classroom with ChatGPT: Pedagogical insights and student outcomes. *Frontiers in Education*, 10. <https://doi.org/10.3389/educ.2025.1574477>.
- Haindl, P., & Weinberger, G. (2024). Students' experiences of using ChatGPT in an undergraduate programming course. *IEEE Access*, 12, 43519–43529. <https://doi.org/10.1109/access.2024.3380909>.
- Hamid, H., Zulkifli, K., Naimat, F., Yaacob, N. L. C., & Ng, K. W. (2023). Exploratory study on student perception of the use of chat AI in process-driven problem-based learning. *Currents in Pharmacy Teaching and Learning*, 15(12), 1017–1025. <https://doi.org/10.1016/j.cptl.2023.10.001>.
- Hays, L., Jurkowski, O., & Sims, S. K. (2024). ChatGPT in K-12 education. *TechTrends*, 68(2), 281–294. <https://doi.org/10.1007/s11528-023-00924-z>.
- Heung, Y. M. E., & Chiu, T. K. F. (2025). *How ChatGPT impacts student engagement from asystematic review and meta-analysis study*. *Computers & Education: Artificial Intelligence*, 8. <https://doi.org/10.1016/j.caeai.2025.100361>.
- Hsu, M. H. (2024). Mastering medical terminology with ChatGPT and Termbot. *Health Educ. J.*, 83(4), 352–358. <https://doi.org/10.1177/00178969231197371>.
- Jahic, I., Ebner, M., & Schon, S. (2023). Harnessing the power of artificial intelligence and ChatGPT in education – A first rapid literature review. In EdMedia Innovate Learning. Association for the Advancement of Computing in Education. <https://www.learntechlib.org/p/222670/>.
- Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large

- language models for education. *Learning and Individual Differences*, 103. <https://doi.org/10.1016/j.lindif.2023.102274>.
- Kim, J., Yu, S., Detrick, R., & Li, N. (2025). Students' perspectives on AI writing. *Education and Information Technologies*, 30(1), 1265–1300. <https://doi.org/10.1007/s10639-024-12878-7>.
- Küchemann, S., Steinert, S., Revenga, N., Schweinberger, M., Dinc, Y., Avila, K. E., & Kuhn, J. (2023). Can ChatGPT support prospective teachers in physics task development? *Physical Review Physics Education Research*, 19(2). <https://doi.org/10.1103/PhysRevPhysEducRes.19.020128>.
- Lo, C. K., Hew, K. F., & Jong, M. S. (2024). The influence of ChatGPT on student engagement: A systematic review and future research agenda. *Computers & Education*, 219. <https://doi.org/10.1016/j.compedu.2024.105100>.
- Lu, J., Zheng, R., Gong, Z., & Xu, H. (2024). Supporting teachers' professional development with generative AI: The effects on higher-order thinking and self-efficacy. *IEEE Transactions on Learning Technologies*, 17, 1279–1289. <https://doi.org/10.1109/tlt.2024.3369690>.
- Mai, D. T. T., Da, C. V., & Hanh, N. V. (2024). The use of ChatGPT in teaching and learning: A systematic review through swot analysis approach. *Frontiers in Education*, 9. <https://doi.org/10.3389/educ.2024.1328769>.
- Maurya, R. K. (2024). A qualitative content analysis of ChatGPT's client simulation role-play for practising counselling skills. *Counselling and Psychotherapy Research*, 24(2), 614–630. <https://doi.org/10.1002/capr.12699>.
- Montenegro-Rueda, M., Fernández-Cerero, J., & Fernández-Batanero, J. (2023). Systematic review of ChatGPT in education. *Computers*, 12(8), 153. <https://doi.org/10.3390/computers12080153>.
- Nassiri, S. H., Khamis, N., & Bunyamin, M. A. H. (2025). Advancing physics and science education through innovative technologies and pedagogical strategies: A review. *International Journal of Education, Psychology and Counselling*, 10(60). <https://doi.org/10.35631/IJEPC.1060052>.
- Nesi, Y. M. D., Kusairi, S., & Nafisah, A. W. L. (2022). Analysis of student perceptions of problem-solving learning and peer assessment. *Momentum: Physics Education Journal*, 6(1), 73–85. <https://doi.org/10.21067/mpej.v6i1.6005>.
- Nugroho, A., Putro, N., & Syamsi, K. (2023). The potentials of ChatGPT for language learning: Unpacking its benefits and limitations. *Register Journal*, 16(2), 224–247. <https://doi.org/10.18326/rgt.v16i2.224-247>.
- Rahman, M. M., & Watanobe, Y. (2023). ChatGPT for education and research: Opportunities, threats, and strategies. *Applied Sciences*, 13(9). <https://doi.org/10.3390/app13095783>.
- Reeve, J., & Cheon, S. H. (2021). Autonomy-supportive teaching: Its malleability, benefits, and potential to improve educational practice. *Educational Psychologist*, 56(1), 54–77. <https://doi.org/10.1080/00461520.2020.1862657>.

- Shahzad, M. F., Xu, S., & Javed, I. (2024). Adoption of ChatGPT in higher education. *International Journal of Educational Technology in Higher Education*, 21, 46. <https://doi.org/10.1186/s41239-024-00478-x>.
- Shams, M. A., Chandio, S. A., Hussain, A. K., Kazmi, S. S. A., & Marwat, A. (2025). Effects of ChatGPT usage on student engagement and learning outcomes. *Journal for Social Science Archives*, 3(1), 546–556. <https://doi.org/10.59075/jssa.v3i1.140>.
- Simangunsong, I. T., Uskenat, K., Damanik, D. P., Simangunsong, I. P., & Purba, A. A. (2024). Improvement of high school students' physics problem-solving skills through problem-based learning assisted by student worksheets (LKPD). *Lensa: Jurnal Kependidikan Fisika*, 12(2), 275–286. <https://doi.org/10.33394/j-lkf.v12i2.13544>.
- Sirnoorkar, A., Laverty, J. T., & Bergeron, P. D. O. (2023). Sensemaking and scientific modeling: Intertwined processes analyzed in the context of physics problem solving. *Physical Review Physics Education Research*, 19(1). <https://doi.org/10.1103/PhysRevPhysEducRes.19.010118>.
- Song Y., Huang L., Zheng L., Fan M., & Liu, Z. (2025). Interactions with generative AI chatbots: unveiling dialogic dynamics, students' perceptions, and practical competencies in creative problem-solving. *Int. J. Educational Technology Higher Education*, 22(12), 1-30. <https://doi.org/10.1186/s41239-025-00508-2>.
- Tlili, A., Shehata, B., Adarkwah, M. A., Bozkurt, A., Hickey, D. T., Huang, R., & Agyemang, B. (2023). What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learning Environments*, 10(1), 5. <https://doi.org/10.1186/s40561-023-00237-x>.
- Urban, M., Děchtěrenko, F., Lukavský, J., Hrabalová, V., Svacha, F., Brom, C., & Urban, K. (2024). ChatGPT improves creative problem-solving performance in university students: An experimental study. *Computers & Education*, 215. <https://doi.org/10.1016/j.compedu.2024.105031>.
- Wang, Y., Chen, X., & Sun, L. (2024). The role of artificial intelligence in promoting student engagement and problem-solving in STEM education. *Journal of Educational Technology & Society*, 27(1), 45–59.
- Wang, J. & Fan, W. (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, 621. <https://doi.org/10.1057/s41599-025-04787-y>.
- Werth, A., Oliver, K. A., West, C. G., & Lewandowski, H. J. (2022). Assessing student engagement with teamwork in an online CURE (course-based undergraduate research experience). *Physical Review Physics Education Research*, 18(2). <https://doi.org/10.1103/PhysRevPhysEducRes.18.020128>.
- Wu, T. T., Lee, H. Y., Li, P. H., Huang, C. N., & Huang, Y. M. (2023). Promoting self-regulation progress and knowledge construction in blended learning via ChatGPT-based learning aid. *Journal of Educational Computing Research*, 61(8), 3–31. <https://doi.org/10.1177/07356331231191125>.

- Yang, T. C., Hsu, Y. C., & Wu, J. Y. (2025). The effectiveness of ChatGPT in assisting high school students in programming learning: Evidence from a quasi-experimental research. *Interactive Learning Environments*, 33(6), 3726–3743. <https://doi.org/10.1080/10494820.2025.2450659>.
- Yilmaz, R., & Karaoglan Yilmaz, F. G. (2023). The effect of generative artificial intelligence (AI)-based tool use on students' computational thinking skills, programming self-efficacy and motivation. *Computers & Education: Artificial Intelligence*, 4. <https://doi.org/10.1016/j.caeai.2023.100147>.
- Záková, K., Urbano, C., & Cruz-Correia, R. (2025). ChatGPT's influence on higher education. *Education and Information Technologies*, 30(1), 649–692. <https://doi.org/10.1007/s10639-024-13184-y>.
- Zhou, W., & Kim, Y. (2024). Innovative music education: An empirical assessment of ChatGPT-4's impact on student learning experiences. *Education and Information Technologies*, 29, 20855–20881. <https://doi.org/10.1007/s10639-024-12705-z>.