Analysis of Student Perceptions and Expectations toward the Utilization of Generative AI as a Learning Assistant in Fundamental Physics Course

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Abstract *- The integration of Generative Artificial Intelligence (GenAI) has transformed higher education, offering innovative possibilities as well as pedagogical challenges. This study examines students' perceptions and expectations regarding the use of AI as a learning assistant in Fundamental Physics Course. Employing a quantitative descriptive survey design based on the Technology Acceptance Model (TAM) and self-regulated learning frameworks, data were collected from 119 undergraduate students in Physics and Mathematics Education at University of Mataram using a 5-point Likert scale questionnaire. The findings indicate highly positive perceptions across all evaluated dimensions: Perceived Ease of Use ($\bar{X} = 4.31$), Student Attitudes ($\bar{X} = 4.19$), Perceived Usefulness ($\bar{X} = 4.08$), Usage Intensity ($\bar{X} = 4.06$), and Learning Impact ($\bar{X} = 3.98$). Students predominantly utilize AI as a cognitive scaffold to summarize lecture materials ($\bar{X} = 4.22$) and facilitate self-directed learning outside class hours ($\bar{X} = 4.25$). Within the Conceptual Change Model (CCM-CCA), AI effectively supports abstract concept understanding ($\bar{X} = 3.97$) and connects theory with real-world applications ($\bar{X} = 4.08$). Furthermore, students demonstrated strong academic maturity, recognizing that AI serves as a tool rather than a replacement for lecturers ($\bar{X} = 4.45$) and acknowledging ethical guidelines ($\bar{X} = 4.37$). However, the relatively lower score on critical thinking development ($\bar{X} = 3.88$) highlights the risk of cognitive offloading and misconceptional pitfalls stemming from AI hallucinations. This study underscores the need to enhance AI literacy and redesign physics assessments toward higher-order thinking skills to ensure deep conceptual mastery.*

Keywords*: Artificial Intelligence; Generative AI; Learning Assistant; Student Perception.*

INTRODUCTION

The integration of Artificial Intelligence (AI), particularly Generative AI (GenAI) such as ChatGPT, Gemini, and DeepSeek, has brought about a fundamental paradigm shift in the higher education ecosystem (Zawacki-Richter et al., 2019; Holmes et al., 2022; Crompton & Burke, 2023). Unlike traditional AI, which focuses on data analysis, *Large Language Models* (LLM) within GenAI are capable of responding to open-ended instructions (*prompt*) and generating human-like content, thereby potentially revolutionizing the way students access and process academic information (Bozkurt, 2023; Kasneci et al., 2023). In *Science, Technology, Engineering, and Mathematics* (STEM) education, particularly Fundamental Physics, the presence of GenAI is regarded as an innovative solution for unpacking abstract concepts, advanced mathematical analysis, and problem-solving, which have often posed a barrier to *self-efficacy* among students (Tan & Cheah, 2021; Ben Zion et al., 2025; Muneer et al., 2026).

On one hand, students and educators hold high expectations that GenAI can function as an ideal learning assistant offering personalization, *real-time* feedback, and task efficiency (Wu et al., 2024). On the other hand, however, the adoption of this technology creates a *double-edged sword effect* that gives rise to serious pedagogical

consequences (Jingwen & Jun, 2026). The ease of GenAI risks triggering *cognitive offloading*, namely a cognitive dependency that erodes critical thinking and the loss of moments of *productive struggle* in problem-solving (Fan et al., 2025). Particularly in exact sciences such as Physics, the tendency of LLMs to generate formulas or theoretical analyses that are linguistically convincing yet scientifically incorrect has strong potential to mislead students with limited AI literacy (Alkaissi & McFarlane, 2023; Zhang et al., 2023). This challenge is further compounded by the blurring of academic integrity boundaries and the absence of the human socio-emotional connection that technology cannot replace (Cotton et al., 2024; Khalid et al., 2026).

Although research on the impact of GenAI continues to grow, the majority of current empirical studies remain focused on language education (EFL), computer science, or the social sciences in general (Dolenc & Brumen, 2024; Rasool et al., 2025; Jingwen & Jun, 2026). To date, research that specifically and comprehensively investigates student perceptions and expectations within the context of Physics especially Fundamental Physics remains very limited. Yet Fundamental Physics has unique characteristics that demand rigorous conceptual understanding and spatial-mathematical reasoning (Makhrus et al., 2023), where misconceptions arising from inaccurate AI-generated information can have a detrimental impact on students' academic performance (Arsi et al., 2025).

The novelty of this study lies in its effort to redefine student agency specifically within the scope of Generative AI-based fundamental science education (Dai et al., 2026). By evaluating how students position themselves and form expectations of AI assistants in solving physics problems, this study provides essential new empirical insights. The findings of this study are expected to serve as a reference for educators and policymakers in designing pedagogical strategies, ethical guidelines, and adaptive AI integration frameworks to minimize cognitive offloading while optimizing deep mastery of physics concepts.

RESEARCH METHODS

This study employed a quantitative descriptive approach using a survey method, aimed at mapping students' perceptions of the use of Generative Artificial Intelligence (GenAI) as a learning assistant in the Fundamental Physics course. The survey method was chosen for its effectiveness in systematically and objectively mapping student perceptions (Knobloch et al., 2024). Descriptive analysis enabled the researchers to identify trends in student perceptions as a basis for formulating recommendations for AI-assisted learning. This method thus supports the achievement of the research objective, namely providing empirical evidence for the development of innovative, ethical, and impactful policies and learning strategies for Fundamental Physics.

The research subjects were students of the Department of Mathematics and Science Education, Faculty of Teacher Training and Education (FKIP), University of Mataram, who were enrolled in the Fundamental Physics course during the 2025 Even Semester academic year. The research object was student perceptions of the use of AI as a learning assistant, encompassing aspects of usefulness, ease of use, support for conceptual understanding, learning autonomy, and implications for academic ethics.

The research instrument was a closed-ended Likert-scale questionnaire developed based on the Technology Acceptance Model

(TAM) and self-regulated learning frameworks. The research instrument used a closed-ended questionnaire with a 5-point Likert scale, namely: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree. Data were analyzed using descriptive statistics to obtain a picture of trends in student perceptions for each indicator (Rasool et al., 2025).. Descriptive analysis was used to describe trends in student perceptions of each variable, including support for conceptual understanding and learning autonomy (self-regulated learning). The results of the analysis were then interpreted qualitatively. The survey was distributed as a Google Form to all classes. The survey was administered during the period of May–June 2026.

RESULTS AND DISCUSSION

Results

a. Survey Participants

A total of 119 students participated in this study, comprising students from the Mathematics Education and Physics Education study programs who were enrolled in the Fundamental Physics course during the 2025 Even Semester academic year. Table 1 presents the survey participant data.

Table 1. Survey Participants

Criteria	Factor	Frequency
Study Program	Mathematics Education	44
	Physics Education	75
Gender	Male	26
	Female	93
Duration of AI Use	<3 Months	5
	3–6 Months	30
	>6 Months	84

b. Student Perception Findings

Student perceptions were divided into several aspects, namely the Ease-of-Use aspect, Usefulness aspect, Attitude aspect, Usage Intensity aspect, and Learning Impact aspect. Table 2 presents an overview of the mean survey results for each aspect.

Table 2. Survey Results for Each Aspect

Aspect / Research Component	$\bar{X}$	SD
Perceived Ease of AI Use	4.31	0.62
Perceived Usefulness of AI in Learning	4.08	0.59
Student Attitudes toward AI	4.19	0.57
Usage Intensity and Patterns of AI	4.06	0.62
Impact of AI on Fundamental Physics Learning	3.98	0.61

Overall, students perceive AI as an easy-to-use tool that supports the learning process. In addition, students hold positive attitudes toward AI, with usage intensity tailored to independent learning. AI also brings positive impacts to classroom instruction. Tables 3 through 7 below present the data for each aspect.

Table 3. Perceived Ease of AI Use

No	Question Item	$\bar{X}$	SD
1	AI is easily accessible when needed	4.48	0.53
2	AI is easy to use without requiring special expertise	4.16	0.71
3	AI can be used across various smart devices (smartphone/laptop)	4.51	0.58
4	The language and explanations provided by AI are easy to understand	4.05	0.58
5	AI is very helpful as a companion for independent learning	4.35	0.55

Table 4. Perceived Usefulness of AI in Learning

No	Question Item	$\bar{X}$	SD
1	AI helps me understand abstract Physics concepts	3.97	0.64

No	Question Item	$\bar{X}$	SD
2	AI helps me complete Fundamental Physics assignments	4.09	0.55
3	AI provides explanations relevant to my learning needs	3.98	0.58
4	AI facilitates my independent learning outside class hours	4.25	0.54
5	AI makes my study time more efficient	4.10	0.62

Table 5. Student Attitudes toward AI

No	Question Item	$\bar{X}$	SD
1	I am interested in using AI in Fundamental Physics learning	4.03	0.48
2	I feel comfortable using AI as a learning assistant	4.06	0.54
3	I believe AI can support my learning process	4.03	0.52
4	I remain aware that AI is a tool, not a replacement for lecturers	4.45	0.56
5	I understand the importance of academic ethics in AI use	4.37	0.58

Table 6. Usage Intensity and Patterns of AI

No	Question Item	$\bar{X}$	SD
1	I frequently use AI to understand Fundamental Physics material given by lecturers	4.10	0.62
2	I use AI for Fundamental Physics practice problems	4.02	0.52
3	I use AI to summarize lecture material and lecturers' explanations	4.22	0.60
4	I use AI independently without lecturer guidance	4.08	0.62
5	AI has become a routine part of my learning activities	3.87	0.70

Table 7. Impact of AI on Fundamental Physics Learning.

No	Question Item	$\bar{X}$	SD
1	AI helps me improve my understanding of Fundamental Physics concepts	3.97	0.54
2	AI helps me connect theory with real-world examples	4.08	0.48
3	AI encourages me to develop critical thinking skills	3.88	0.67
4	AI helps me evaluate my understanding independently	4.02	0.61
5	AI increases my learning motivation and interest	3.94	0.72

Discussion

The research results indicate that, overall, students hold highly positive perceptions of the integration of Artificial Intelligence (AI) in Fundamental Physics learning. This is reflected in the mean scores across all perception aspects, which fall into the high to very high category: Ease of Use ($\bar{X} = 4.31$), Student Attitudes ($\bar{X} = 4.19$), Usefulness in Learning ($\bar{X} = 4.08$), Usage Intensity and Patterns ($\bar{X} = 4.06$), and Impact on Learning ($\bar{X} = 3.98$). These findings indicate that AI has been widely adopted by students as an effective *scaffolding* tool or independent learning assistant.

AI as Cognitive *Scaffolding* and Expectations in Fundamental Physics Learning

Fundamental Physics is a discipline that demands abstract reasoning, mathematical representation, and structured conceptual understanding. The high perceived ease of use ($\bar{X} = 4.31$) and usefulness ($\bar{X} = 4.08$) confirm that AI functions as a *cognitive tool* that reduces students' *extraneous cognitive load*.

Students predominantly use AI to summarize lecture material and explanations ($\bar{X} = 4.22$) and to facilitate independent learning outside class hours ($\bar{X} = 4.25$). In the context of physics, AI's ability to break down systematic equations and present verbal/conceptual visualizations helps students bridge the limitations of in-class learning time. This finding is consistent with the theory of *Self-Directed Learning* (SDL), in which artificial intelligence provides students with flexible space to learn at their own cognitive *pacing*. This is also consistent

with the study by Hikmawati *et al* (2026), which found that AI-assisted learning improves students' HOTS abilities.

AI Integration in Learning and Concept Development

One of the greatest challenges in Fundamental Physics learning is the high rate of misconceptions (students' prior conceptions that are inconsistent with established physics principles). One learning model designed to address this is the Conceptual Change Model (CCM), particularly through a cognitive conflict approach (CCM-CCA) (Makhrus et al., 2023; Makhrus & Hidayatullah, 2025). The CCM-CCA requires the assimilation of prior understanding with new understanding. The survey results reveal AI's strategic role within the CCM-CCA framework. AI was rated as highly helpful in understanding abstract Physics concepts ($\bar{X} = 3.97$) and connecting theory with real-world examples ($\bar{X} = 4.08$). When students experience cognitive conflict when confronting counterintuitive physics problems (such as Newton's Third Law or the concept of Electric Fields), AI can provide repeated rational explanations in easily understandable language ($\bar{X} = 4.05$) until the concept becomes *plausible*.

Students felt that AI helped them evaluate their understanding independently ($\bar{X} = 4.02$) and with practice problems ($\bar{X} = 4.02$). Through repeated practice problems guided by real-time AI feedback, students verified the fruitfulness of the new scientific concepts they had learned. However, on the item "AI encourages me to develop critical thinking skills," the score obtained was the lowest among the impact-related items ($\bar{X} = 3.88$). Within the CCA framework, this offers an important pedagogical warning: AI alone does not automatically trigger deep conceptual change if students remain passive recipients of AI-generated answers. Without active cognition or a push toward concept reconstruction, AI functions merely as a rapid *answer generator* rather than a trigger for *conceptual change* (Taufik et al., 2025).

Connections with Other Innovative Learning Models

In the PBL model, AI can serve as an idea-restructuring agent (*ideation partner*) that helps students formulate hypotheses and search for initial analogies when solving authentic physics problems. Students' independent use of AI without lecturer guidance ($\bar{X} = 4.08$) reflects a high degree of *student agency*, which is a core foundation of the *inquiry* model.

Given the high intensity with which students use AI to process material independently before/after class ($\bar{X} = 4.10$), lecturers can implement the *Flipped Classroom* model more effectively. In-class face-to-face sessions can then be optimized for higher-order cognitive discussion (*High-Order Thinking Skills* / HOTS), laboratory experiments, and clarification of AI hallucinations or analytical errors, while mastery of foundational concepts is guided by AI outside of class.

Ethical Awareness, Lecturer Agency, and the Risk of *Cognitive Offloading*

Crucially, the findings of this study reveal a high degree of academic maturity among students:

a. **Distinction between the Roles of AI and Lecturers ($\bar{X} = 4.45$):** Students very clearly recognize that AI is merely a *tool* and cannot replace the lecturer's role as facilitator, emotional mentor, and authentic assessor.
b. **Awareness of Academic Ethics ($\bar{X} = 4.37$):** Students understand the importance of integrity and ethics in using AI.

Nevertheless, there are risk gaps that physics instructors must anticipate. The mean score for the item "AI has become a routine part of learning activities" ($\bar{X} = 3.87$) and the relatively lower critical thinking indicator ($\bar{X} = 3.88$) point to a potential for cognitive dependency (*cognitive offloading*). If students rely too heavily on AI-generated answers without scientific verification (such as checking units/dimensions, mathematical consistency, or physical logic), this can instead foster new misconceptions caused by "AI hallucinations" (Alkaissi & McFarlane, 2023).

Therefore, the integration of AI into the Fundamental Physics curriculum must be balanced with enhanced *AI Literacy* and lecturer-driven pedagogical interventions. Physics lecturers need to design assessments that demand metacognition, critical evaluation of AI-generated answers, and *multi-representation reasoning* that cannot be resolved simply through *copy-paste* of simple *prompting* commands to AI.

CONCLUSION

This study concludes that students in the Mathematics Education and Physics Education programs hold highly positive perceptions of the integration of Generative AI as a learning assistant in Fundamental Physics. AI has proven effective as a cognitive *scaffolding* and a means of *self-directed learning* that facilitates access to information, supports understanding of abstract concepts, and enhances the efficiency of independent learning outside class. Within the framework of the *Conceptual Change Model* (CCM-CCA) and innovative learning models such as *Problem-Based Learning* and *Flipped Classroom*, AI functions as an *ideation partner* that helps facilitate concept assimilation and problem-solving.

Although students demonstrated a high level of ethical awareness and understood that AI cannot replace the lecturer's role, this study identifies a pedagogical risk in the form of *cognitive offloading* and the potential emergence of misconceptions due to "AI hallucinations," given that the critical thinking development indicator obtained the lowest score. Therefore, the use of AI in Fundamental Physics learning requires strengthened AI literacy, active lecturer intervention, and the design of assessments based on higher-order thinking (*HOTS*) and critical reasoning to ensure deep mastery of scientific concepts.

These findings contribute meaningful empirical evidence toward enhancing fundamental physics education by aligning instructional design with student acceptance and behavioral patterns. Future physics curricula should be structured around interactive, technology-enhanced environments. In particular, developing targeted AI-integrated instructional models or learning media will be vital for fostering student engagement, cultivating critical reasoning, and safeguarding against cognitive offloading.

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