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THE EFFECTS OF GENERATIVE AI TOOLS ON STEM STUDENTS' INFORMATION LITERACY IN BIOLOGY

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ABSTRACT

This study, conducted from January to July 2026, aimed to determine the adverse effects of generative AI tools on STEM students' information literacy in Biology. Specifically, it examined students' use of these tools in terms of personalized tutoring, content creation, and feedback and assessment, as well as their adverse effect on locating information, analyzing information, and responsible use of information. The research surveyed one hundred thirty-five (135) Grade 11 STEM students from a public high school in Sariaya, Quezon, using total population sampling. A descriptive-correlational method with a quantitative approach was employed, and data were collected using self-made survey questionnaire. Statistical tools used for analysis included Weighted Arithmetic Mean (WAM) to determine the use and adverse effects of generative AI tools and Spearman's rho to determine the significant relationships between generative AI tools usage and students' information literacy in Biology. Findings revealed that students frequently use generative AI tools for personalized tutoring, content creation, and feedback and assessment. However, these tools show significant adverse effects on students' information literacy, particularly in locating information, with a WAM of 2.64, indicating that students' overreliance on AI-generated content reduced their initiative to explore multiple credible references. Furthermore, statistical analysis confirmed significant relationship between generative AI tool usage and locating information, while the relationship with analyzing information and responsible use of information was limited. Based on these findings, the researchers proposed guidelines aimed at promoting the effective and responsible use of generative AI tools to enhance STEM students' information literacy in Biology.

Keywords: *Biology, generative AI tools, information literacy, STEM*

INTRODUCTION

Generative AI tools are digital systems designed to learn from comprehensive data collection and have the capability to generate new responses, feedback, or content that is based on the presented user information (Harvard University Information Technology, 2023). In essence, these tools encode patterns in existing information and produce new outputs across conversational, writing, image, and code applications (Glance, 2025; Lawton, 2024). These imply that generative AI tool integration in education can influence the information literacy of the students.

Additionally, generative AI tools are particularly useful in self-directed learning, where students use them as writing assistants or on-demand tutors to practice writing, brainstorm ideas, and receive immediate feedback (Saarela, 2026). In relation, Filipino learners are increasingly using these tools for homework, research, idea generation, and understanding complex concepts (Miranda et al., 2024; Aligato & Saligumba, 2025). With that, these tools can serve as an academic assistance system to enhance learning, particularly through personalized tutoring, content creation, and feedback and assessment.

According to Mapúa University (2025), personalized tutoring through generative AI tools emphasizes the use of Large Language Models (LLMs) to replicate one-on-one tutoring sessions that are adjusted to each student's skill level, learning preferences, and goals. In connection, Bluechip Technologies Asia (2025) stated that this personalized approach is more inclusive and takes into consideration the varied learning preferences of individual students. Moreover, research indicates that AI-enhanced tutoring improves engagement, understanding, and learning independence among students (Diaz et al., 2025; Legas & Mamaril, 2025). Meanwhile, Chugh et al. (2025) defined content creation as the use of generative artificial intelligence technologies to produce content like text, photos, videos, and music, using patterns from existing sources of data. Furthermore, AI use enhances efficiency and interdisciplinary collaboration (Agarwal & Khattar, 2025; Yan & Qianjun, 2025).

Along with these functions, feedback and assessment are also important applications of generative AI tools. Prompiengchai et al. (2025) emphasize that generative AI can generate immediate, contextualized, and personalized feedback during formative assessment by analyzing learner inputs and producing scaffolded responses. This allows students to receive feedback while learning, rather than only after evaluation, potentially increasing engagement and learning gains. These findings show how generative AI tools can support different learning processes, although their effects may also depend on how students use the information they provide.

However, while these tools enhance learning efficiency through quick information access and facilitating better organization, analysis, and understanding of complex concepts (Moquin, 2025; Bogalin et al., 2025), they also present negative influences. Whereas the excessive dependency on generative AI tools may weaken critical thinking and source-evaluation skills, which results in plagiarism, misinformation, and biases (Bailey, 2024). In relation, excessive reliance on AI systems may encourage students to

prefer quick and convenient answers, leading them to avoid formulating their own search queries, refining keywords, and consulting multiple sources (Zhai et al., 2024). This indicates that although generative AI can potentially support information literacy, it may also negatively affect how students utilize information if not used properly.

In view of these benefits and risks, information literacy is crucial for STEM students. As stated by Henson (2021), information literacy has growing significance in a society driven by technology, as this includes the capability of an individual to locate, evaluate, and use information effectively. In this study, information literacy is examined in terms of locating information, analyzing information, and responsible use of information. Dahlen and Hanson (2023) stated that several aspects, such as choosing resources, strategies to overcome unsuccessful searches, and alignment with instructors' expectations, affect how students find information. This suggests that locating information is not only about access but also about the strategic decisions that students make when searching. Meanwhile, as stated by Valmores and Acedera (2024), analyzing information is the ability of an individual to evaluate, interpret, and verify content in order to ensure its accuracy. In addition, Del et al. (2024) highlighted strategies that students use to assess the reliability of online sources, such as examining language, references, consistency, authority, currency, and objectivity.

Lastly, responsible use of information extends beyond simply locating and analyzing sources. Du (2024) described the responsible use of information as encompassing not just the ability to search, access, assess, and process information, but also being aware of its legal and ethical implications, particularly regarding anti-plagiarism practices. Correspondingly, Mills and Gutierrez (2025) stated that information literacy is not limited to technical competence in using digital tools, but it also requires ethical awareness and critical use of these tools. These perspectives highlight that information literacy involves not only finding information but also evaluating its accuracy and applying it ethically and responsibly, especially when using AI-generated content.

Regarding Biology, as a subject taken by the STEM student, it focuses on living organisms, such as their structures, functions, evolution, and interactions within ecosystems. It also covers fields such as genetics, microbiology, physiology, and ecology that rely on scientific inquiry, critical thinking, research, and evidence-based reasoning skills (Barrickman et al., 2026; Jeffery et al., 2016). Given this, information literacy is relevant to Biology, as students must critically interpret scientific data, evidence, and AI-generated content to ensure scientific accuracy. As noted by Almasri (2024), the enhancement of academic performance and understanding of complex scientific concepts is influenced by the use of AI tools. Thus, in Biology learning, these tools can provide assistance in research, clarify complex biological concepts, and assist in data analysis. However, the availability of AI-generated explanations does not remove the need for students to evaluate the information carefully and determine whether it is accurate and appropriate for their learning.

Moreover, the Department of Education (DepEd) in the Philippines has initiated Project AGAP.AI (Accelerating Governance and Adaptive Pedagogy through Artificial Intelligence), which encourages students, teachers, and school administrators to use AI

tools ethically through curriculum support and organized training (Martinez, 2026). With that, this initiative is relevant, as it can support the students in the critical and responsible use of AI-generated scientific information.

Considering all this, although the application of generative AI tools to learning has become more prevalent, there still a lack of research exploring their influence on information literacy. Some studies show that students demonstrated strong technical skills in utilizing AI tools and revealed the possibility of enhancing learning effectiveness (Galagala & Bacarrisas, 2025). However, they may also weaken higher-order competencies like critical thinking and source evaluation (Li & Balinas, 2025). In line with this, existing literature shows that information literacy is the strongest indicator of academic success among Filipino learners who are knowledgeable of the capabilities and ethical implications of AI (Esponilla II et al., 2025; Ignas, 2025). Taken together, these findings emphasize that beyond AI benefits and technological proficiency, the ability to critically engage with information remains essential for student achievement.

However, further investigation is needed to understand how the use of generative AI tools relates to students' information literacy, particularly in the subject of Biology. Therefore, in response to that, this research aimed to determine the adverse effects of generative AI tools on STEM students' information literacy in Biology, specifically focusing on their use in Biology class in terms of personalized tutoring, content creation, and feedback and assessment, as well as students' information literacy in terms of locating, analyzing, and responsible use of information.

Research Questions

This study aimed to determine the adverse effects of generative AI tools on STEM students' information literacy in Biology.

Specifically, it sought to answer the following research questions:

1. What is the use of generative AI tools in the Biology class of the respondents in terms of:
   1.1 Personalized tutoring;
   1.2 Content creation; and
   1.3 Feedback and assessment?
2. What are the adverse effects of generative AI tools on STEM students' information literacy in Biology learning in terms of:
   2.1 Locating information;
   2.2 Analyzing information; and
   2.3 Responsible use of information?
3. Is there a significant relationship between the use of generative AI tools and the information literacy of the students in Biology?Based on the research findings, what set of guidelines can be developed to promote the effective and responsible use of generative AI tools in enhancing students' information literacy in Biology?

Hypothesis

There is no significant relationship between the use of generative AI tools and the information literacy of the students in Biology.

METHODOLOGY

Research Design

The researchers utilized a descriptive-correlational research design in a quantitative research approach to determine the adverse effects of generative AI tools on STEM students' information literacy in Biology.

According to Brodowicz (2024), the descriptive-correlational research design aims to explain the attributes of a phenomenon or population being studied while simultaneously examining the link among variables, without manipulating them. This enables the researchers to investigate whether there is an existence of correlation among variables. Moreover, Sreekumar (2023) describes the quantitative research approach as the systematic collection and analysis of numerical data that aims to generalize findings among large population samples.

This research design was utilized by the researchers because it is anchored to the study and enables the collection of the needed measurable data through surveys. In relation, the descriptive method was employed to describe the use of generative AI tools in Biology in terms of personalized tutoring, content creation, and feedback and assessment. Also, the same method was utilized to describe the adverse effects of generative AI tools on STEM students' information literacy in Biology, particularly in locating, analyzing, and responsibly using information. On the other hand, the correlational method allowed the researchers to identify whether there is a relationship between the use of generative AI tools and the information literacy of the students in Biology.

Research Locale

The researchers conducted this study in one public high school in Sariaya, Quezon, that offers classes to senior high school levels under the Philippine K-12 Basic Education Curriculum. This school is officially authorized by the Department of Education to offer various academic strands, including Science, Technology, Engineering, and Mathematics (STEM), which allows students to take Biology and other science subjects (DepEd Quezon, 2023). In addition, the school operates within standard school hours for secondary institutions in the region.

Moreover, according to the observations, insights, and experiences gathered from informal interviews conducted by the researchers, this school is suited for this study. In particular, the student population demonstrates a wide variety of academic skills and different levels of prior exposure to science, which influence how students locate, analyze,

and responsibly use information in Biology. Additionally, DepEd Order No. 003 has recently been issued by the Department of Education, which is referred to as "Foundational Guidelines on Artificial Intelligence in Basic Education," which encourages the appropriate use of AI tools in basic education, especially for public school teachers and students. (Sevillano, 2026). Considering this increasing integration of generative AI applications in education, these resources are actively utilized by the students in their learning process. Therefore, this engagement highlights the need to explore their effects on the information literacy of STEM students to promote more effective learning in the subject of Biology.

With this, the study aimed to determine the adverse effects of generative AI tools on STEM students' information literacy in Biology and be able to develop a set of guidelines that can promote the effective and responsible use of generative AI tools in enhancing the information literacy of the students in Biology.

Research Population and Sample

In this research, the respondents consisted of all Grade 11 STEM students in the chosen public high school in Sariaya, Quezon, during the academic year 2025–2026. Specifically, the target population is precisely composed of one hundred thirty-five (135) students who are currently taking Biology as part of their prescribed curriculum.

In this study, the total enumeration sampling technique was utilized in selecting the respondents. According to Vijayamohan (2022), total enumeration sampling includes all members of the defined population who possess similar attributes and are therefore included in the study. These shared characteristics may include special experiences, knowledge, or abilities relevant to the research objectives. Thus, this sampling technique is considered appropriate, as the adverse effects and use of generative AI tools may vary among students. With that, including the entire population enables a more comprehensive and accurate analysis of these effects.

Furthermore, all Grade 11 STEM students are deemed suitable respondents, as this strengthens the reliability of the data, and their academic background and subject exposure enable them to give pertinent and reliable answers on the adverse effects of generative AI tools on STEM students' information literacy in Biology.

Research Instrument

The researchers utilized a self-made survey questionnaire in this study. This instrument is specifically designed to determine the adverse effects of generative AI tools on STEM students' information literacy in Biology and to systematically gather information on their views and experiences with these tools.

The survey questionnaire is composed of two parts, with each corresponding to the key variable of the study. The first part identifies the use of generative AI tools in biology, including personalized tutoring, content creation, and feedback and assessment. Then, the second part determines the adverse effects of generative AI tools on STEM students'

information literacy in Biology, particularly in terms of locating information, analyzing information, and the responsible use of information. Moreover, each part contains ten (10) statements per variable, making a total of sixty (60) items. In connection, a four-point Likert scale was utilized to measure the first and second parts, with 4 representing "Strongly Agree (SA)," 3 meaning "Agree (A)," 2 for "Disagree (D)," and 1 representing "Strongly Disagree (SD)."

Furthermore, the questionnaire underwent a validation process prior to administration of the research instrument in order to guarantee its validity, clarity, and relevance. In particular, the initial review of the research instrument was carried out by the research adviser to make sure of the appropriateness of the items to the research objectives and variables. Then, it was examined by the statistician to ensure that the statistical treatments utilized in the survey questionnaire enable the accurate analysis of the data that was gathered. Following this, two content experts in the field of science assessed the alignment, relevance, and accuracy of the statements. Then, the last validator is an English language expert who reviewed the grammar, clarity, and appropriateness of the language used. Afterwards, the feedback and suggestions given by the validators were thoughtfully analyzed and applied to enhance the questionnaire's overall validity, reliability, and quality.

Ultimately, the finalized survey questionnaire was distributed to the selected respondents after the validation and refinement process. Then, eventually, the responses were collected immediately to ensure their accuracy and completeness.

Data Gathering Procedures

This study followed several procedures to gather the necessary data for the study. First, the researchers obtained the relevant permits, which include a formal letter asking to identify the total number of the target population and permission to conduct the study.

Next, upon approval of the permits, the teachers of the respondents were informed about the data collection to be conducted. Also, the letter approved by the principal was presented to ensure full cooperation from the teachers. Following that, the questionnaires were distributed by the researchers via printed copy to the selected respondents within one to two weeks.

Along with the survey questionnaire, the parents and respondents received an informed consent letter together with a confidentiality agreement in accordance with the Data Privacy Act of 2012. This guaranteed that the responses of the respondents were used only for academic purposes and were maintained strictly confidential.

After the allotted time, the completed survey questionnaires are retrieved by the researchers, and the gathered data are organized, encoded, and systematically analyzed. Then, the data was interpreted using proper statistical treatments and presented in tabular form to facilitate clear analysis and discussion of the findings. In addition to this, the completed survey questionnaire was placed in a secure storage container with a clear label indicating its confidentiality to guarantee that the data gathered from the

respondents remains protected, and only the researchers have access to these documents to maintain the confidentiality and privacy of the respondents.

Moreover, all questionnaires would be preserved by the researchers for a duration of three (3) years following the completion of the study. After this, the questionnaires and any physical records containing information about respondents would be disposed of in a manner that would ensure the protection of the confidential information of respondents.

Statistical Treatment

The following statistical measures and tools are used in this study to help the researchers present, analyze, and interpret the data gathered.

For the first statement of the problem, the Weighted Arithmetic Mean (WAM) was utilized by the researchers in order to determine the use of generative AI tools in Biology class, particularly in personalized tutoring, content creation, and feedback and assessment.

Similarly, for the second statement of the problem, Weighted Arithmetic Mean (WAM) was also used by the researchers to determine the adverse effects of generative AI tools on STEM students' information literacy in Biology, in terms of locating information, analyzing information, and the responsible use of information. The formula is shown below:

Formula:

$$W = \frac{\sum_{i=1}^{n} W_i X_i}{\sum_{i=1}^{n} W_i}$$

Where:

W = weighted mean
n = number of terms to be averaged
W_i= corresponding weight
Xi = value of any particular

The researchers employed a 4-Point Likert Scale and interpreted the result using the continuous scale below:

Point Scale	Mean Range	Verbal Interpretation
4	3.26 – 4.00	Strongly Agree
3	2.51 – 3.25	Agree
2	1.76 – 2.50	Disagree
1	1.00 – 1.75	Strongly Disagree

Grájeda, A., Burgos, J., Olivera, P. C., & Sanjinés, A. (2023). *Assessing student-perceived impact of using artificial intelligence tools.*

Moreover, as for the third statement of the problem, the Spearman Rho statistical method was utilized by the researchers to test for a significant correlation between the

use of generative AI tools and the information literacy of the students in Biology. The formula is shown below:

Formula:

$$p = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$$

Where:

p = Spearman's rank coefficient
d_i = difference between the two ranks of each observation
n = number of observations

To assess the relationship between variables, the researchers analyzed the correlation coefficient (r) using the continuous scale below:

Value of r	Correlation Coefficient
± > 0.70	Very Strong Positive/Negative Relationship
± 0.40 to ± 0.69	Strong Positive/Negative Relationship
± 0.30 to ± 0.39	Moderate Positive/Negative Relationship
± 0.20 to ± 0.29	Weak Positive/Negative Relationship
± 0.01 to ± 0.19	No or Negligible Positive/Negative Relationship

Abdullah Abdulaziz Bawazir, Kamal, A., Lean, G. L., Lee, L., Ng Seong Kai, Sarina Mohamad Nor, & Aina, P. (2023). *Factors Affecting Consumer Acceptance of E-Menu in The Klang Valley Restaurant Sector in Malaysia.*

Scope and Limitation

This study focused on determining the adverse effects of the generative AI tools on the STEM students' information literacy in Biology. Specifically, it examined the use of generative AI tools in the biology class of the respondents, particularly in personalized tutoring, content creation, and feedback and assessment, as well as their effects on the students' information literacy, particularly in terms of locating, analyzing, and responsible use of information.

Selected students from one of the public high schools in Sariaya, Quezon, under the Sariaya West School District, served as the respondents of the study. With a total population of one hundred thirty-five (135) Grade 11 students from the STEM strand who were taking the Biology subject during the school year 2025-2026. In connection with this, using a quantitative approach, the researchers employed a descriptive-correlational research design and utilized a total enumeration sampling technique. Furthermore, the data were gathered through a self-made survey questionnaire, which was distributed in printed form to the respondents. Wherein, the administration of the questionnaire was conducted within one to two weeks, depending on the availability of the respondents and the school schedule. To analyze the collected data, the Weighted Arithmetic Mean (WAM) was utilized to determine the use and the adverse effects of generative AI tools on the information literacy of the students. Then, Spearman's rho was utilized to analyze the connection between the use of generative AI tools and the information literacy of the students in Biology. Ultimately, the output of the study is a set of guidelines intended to

promote the effective and responsible use of the generative AI tools in enhancing the information literacy of the students in Biology.

However, despite its defined scope, this study still has certain limitations. One of the actual limitations is the availability of the respondents since the data gathering might coincide with the academic deadlines and other school-related activities. Another limitation noted here is the relatively short period of data collection, which constrains the depth of information gathered through the survey questionnaire. To address these limitations, the researchers worked in collaboration with the subject teachers and school administrators to make sure that the data were collected in accordance with the convenient time of the respondents to avoid any disruption to school activities. Furthermore, the researchers also provided clear instructions and explanations to the respondents to encourage them to provide honest responses to questions that would help improve the reliability of the information gathered.

RESULTS

Part I. Use of Generative AI Tools in Biology Class

This section presents the students' use of generative AI tools in Biology class in terms of personalized tutoring, content creation, and feedback and assessment.

Table 1
Use of Generative AI Tools in Biology Class in terms of Personalized Tutoring

No.	Indicators	WAM	Verbal Interpretation
	Generative AI Tools…		
1	helps me to personally understand difficult biology concepts.	3.46	Strongly Agree
3	clarify my misunderstandings of ideas or terms.	3.42	Strongly Agree
2	provides examples that illustrate how concepts are applied.	3.39	Strongly Agree
9	support my learning when assistance from others is unavailable.	3.38	Strongly Agree
4	Respond to my questions interactively.	3.33	Strongly Agree
5	Give me practice exercises that personally develop my skills.	3.17	Agree
8	introduce me to related concepts beyond classroom discussion.	3.16	Agree
10	Adjust guidance according to my learning needs.	3.16	Agree
6	Assist me in individually preparing for biology quizzes or examinations.	3.14	Agree
7	Help me to personally recognize my learning weaknesses.	3.03	Agree
	Average Weighted Arithmetic Mean	**3.27**	**Strongly Agree**

Table 2
Use of Generative AI Tools in Biology Class in terms of Content Creation

No.	Indicators	WAM	Verbal Interpretation
	Generative AI Tools…		
1	Provide ideas when I brainstorm for projects.	3.50	Strongly Agree

4	guide me in structuring presentations or reports.	3.36	Strongly Agree
7	Summarize the learning materials for me.	3.29	Strongly Agree
2	generate sample outputs that I can use for my biology tasks.	3.28	Strongly Agree
6	Help me combine insights from multiple biology references.	3.28	Strongly Agree
8	Assist me in paraphrasing information appropriately.	3.27	Strongly Agree
3	Help me draft biology reports, assignments, or projects.	3.22	Agree
5	arrange my information into logical sequences.	3.19	Agree
9	improve the coherence of my writing.	3.16	Agree
10	Help me create visual or multimedia learning elements.	3.03	Agree
	Average Weighted Arithmetic Mean	**3.26**	**Strongly Agree**

Table 3

Use of Generative AI Tools in Biology Class in terms of Feedback and Assessment

No.	Indicators	WAM	Verbal Interpretation
	Generative AI Tools…		
8	Help me identify concepts I have not fully understood.	3.39	Strongly Agree
3	Recommend ways for me to improve my outputs.	3.38	Strongly Agree
9	provide feedback that guides my next learning steps.	3.26	Strongly Agree
7	Support my preparation for biology assessments.	3.25	Agree
4	Provide practice questions for self-checking.	3.24	Agree
5	Show me the correct reasoning for comparison.	3.24	Agree
10	Encourage me to reflect on my learning.	3.24	Agree
1	Evaluate my responses immediately.	3.19	Agree
2	Help me detect errors in my biology work.	3.16	Agree
6	Help me monitor my learning progress over time.	3.05	Agree
	Average Weighted Arithmetic Mean	**3.24**	**Agree**

Part II. Adverse Effects of Generative AI Tools on the Information Literacy of Students in Biology Learning

This section presents the adverse effects of generative AI tools on the information literacy of the students in Biology learning in terms of locating information, analyzing information, and responsible use of information.

Table 4

Adverse Effects of Generative AI Tools on the Information Literacy of Students in Biology Learning in terms of Locating Information

No.	Indicators	WAM	Verbal Interpretation
7	I find it challenging to locate updated or recent biological information when relying on AI tools.	2.78	Agree
1	I find it difficult to start a research task without using an AI tool first.	2.73	Agree
6	I find it challenging to construct effective prompts in AI tools, which affects my ability to find accurate and reliable information.	2.70	Agree
5	I find it challenging to develop effective search strategies when I rely heavily on AI.	2.66	Agree
9	I find it difficult to invest time in searching for information independently since AI provides information instantly.	2.66	Agree
8	I find it challenging to locate accurate information on my own without using AI.	2.62	Agree
10	I limit my use of other biology resources when using AI.	2.59	Agree

2	I depend on AI to generate keywords and search terms, rather than developing my own search strategies.	2.55	Agree
3	I find it difficult to determine which search platforms or sources to use without relying on the AI tools I have access to.	2.55	Agree
4	I struggle to navigate physical or digital library databases without AI guidance.	2.54	Agree
	Average Weighted Arithmetic Mean	**2.64**	**Agree**

Table 5

Adverse Effects of Generative AI Tools on the Information Literacy of Students in Biology Learning in terms of Analyzing Information

No.	Indicators	WAM	Verbal Interpretation
8	I sometimes overlook sources when AI provides reasonable answers.	2.67	Agree
1	I reduce my effort in analyzing biology content when using AI.	2.59	Agree
9	I find it difficult to cross-check AI-generated biology concepts with textbooks or peer-reviewed journals.	2.51	Agree
4	I struggle to synthesize biological information from multiple sources without depending on AI.	2.51	Agree
3	I find it difficult to resolve conflicting biology information on my own without relying on AI's interpretation.	2.47	Disagree
10	I struggle to recognize bias in AI-generated information.	2.43	Disagree
7	I struggle to spot errors in AI-generated content.	2.38	Disagree
6	I ignore inconsistencies in the information provided by AI tools.	2.24	Disagree
2	I let AI determine which information is important without my own judgment.	2.21	Disagree
5	I accept AI-generated conclusions without logical analysis.	2.08	Disagree
	Average Weighted Arithmetic Mean	**2.41**	**Disagree**

Table 6

Adverse Effects of Generative AI Tools on the Information Literacy of Students in Biology Learning in terms of Responsible Use of Information

No.	Indicators	WAM	Verbal Interpretation
6	I overlook whether AI-generated biological data are ethically appropriate to be used for academic reports.	2.44	Disagree
3	I tend to overlook plagiarism risks when using AI.	2.41	Disagree
5	I reduce my adherence to academic integrity guidelines when using AI tools.	2.36	Disagree
4	I sometimes present AI-generated work as my own.	2.27	Disagree
2	I prioritize convenience over proper referencing when using AI.	2.27	Disagree
1	I use AI-generated content without citing the source.	2.06	Disagree
7	I rely on AI to the point that I no longer follow standard digital and academic integrity protocols for biology assignments.	2.04	Disagree
9	I copy AI responses directly into my assignments.	1.97	Disagree
8	I use AI-generated content without reviewing its accuracy or appropriateness.	1.93	Disagree
10	I submit work based on AI outputs without reviewing them carefully.	1.89	Disagree
	Average Weighted Arithmetic Mean	**2.16**	**Disagree**

Part III. Significant Relationship Between the Usage of Generative AI Tools and the Information Literacy of the Students in Biology

The section below presents the results of the analysis of the significant relationship between the use of generative AI tools and the information literacy of the students in Biology.

Table 7
Significant Relationship Between the Usage of Generative AI Tools and the Information Literacy of the Students in Biology

Use of generative AI tools	Adverse Effects of generative AI tools					
	Locating Information		Analyzing Information		Responsible Use of Information	
	r	*p*-value	*r*	*p*-value	*r*	*p*-value
Personalized Tutoring	0.198*	0.021	0.079	0.362	0.067	0.441
Content Creation	0.246**	0.004	0.151	0.080	0.109	0.209
Feedback and assessment	0.324**	0.000	0.192*	0.025	0.152	0.078

DISCUSSION

This section presents and interprets the findings of the study in relation to its objectives, following the sequence of the research questions: use of generative AI tools in Biology class; adverse effects of generative AI tools on students' information literacy; and the significant relationship among variables.

Part I. Use of Generative AI Tools in Biology Class

1.1. Use of Generative AI Tools in Biology Class in terms of Personalized Tutoring (Table 1)

The use of generative AI tools in Biology class in terms of Personalized Tutoring garnered a total weighted arithmetic mean of 3.27, with a Strongly Agree verbal interpretation, which implies that students are generally using generative AI tools, as it can provide immediate and personalized academic support. In line with this, the strong agreement indicates that students rely on these tools, as this enables them to ask questions freely, engage more deeply with the lesson, and receive simplified explanations, as well as bridge gaps in their understanding that may not always be addressed in a traditional classroom, particularly when teachers and peers are not immediately available, making learning more flexible and independent.

In relation to this, among the indicators, the statement *"Generative AI tools help me to personally understand difficult biology concepts"* scored the highest WAM of 3.46, and has an interpretation of Strongly Agree. This indicates that students primarily used generative AI tools for enhancing their conceptual understanding in Biology, since this

subject often involves interconnected systems and unfamiliar terminology. This reinforces the idea that these tools help make complicated biological concepts simpler and easier to understand. Moreover, consistent high ratings for clarifying misunderstandings and providing examples illustrate the application of concepts that emphasize that generative AI tools support deeper cognitive engagement, allowing learners to think more deeply by analyzing and comprehending information rather than just memorizing it. Collectively, this implies that the use of these tools extends beyond basic assistance and may positively influence the way students process biological concepts, which contradicts the expected direction of the hypothesis.

Conversely, the statement *"Generative AI tools help me to personally recognize my learning weaknesses"* attained the lowest WAM of 3.03, which is verbally interpreted as Agree. This demonstrates that even though generative AI tools are great supplementary tutors that help motivate students to take an active part in their learning process, their role in promoting self-assessment and reflective learning may be less evident compared to other indicators, as students tend to use these tools for obtaining explanations rather than evaluating their own level of understanding. Additionally, this highlights that generative AI tools may affect cognitive processes more than reflective practices of the students.

These findings align with Tetzlaff et al. (2020), who mentioned that personalized tutoring can be defined as an instructional method that is flexible enough to meet the needs, pace, and level of understanding of the individual learner, allowing for more targeted and meaningful learning experiences. According to Binhammad et al. (2024) and Mapúa University (2025), generative AI applications function as AI-driven tutors that simulate one-on-one instruction by providing real-time explanations, examples, and feedback that is personalized to the specific needs of each student and level of competence. These imply that students benefit from generative AI tools as personalized tutors by gaining immediate support that helps them understand complex Biology concepts in a more accessible and structured way.

Moreover, LunarTech AI (2025) emphasized that these tools allow students to learn independently while receiving immediate academic support, which promotes flexibility and accessibility in learning compared to traditional classroom settings. Similarly, Diaz et al. (2025) stated that AI-assisted tutoring enhances the engagement, conceptual understanding, and learning independence of the students, particularly in STEM subjects where concepts are complex and interconnected. These tools support cognitive development by breaking down complex ideas into simpler explanations, step-by-step processes, and contextual examples, which help students analyze and interpret biological concepts more effectively.

However, some literature presents contrasting findings regarding the effectiveness of personalized tutoring. As noted by Ortiz et al. (2025), although generative AI tools provide immediate and tailored support, challenges such as the delivery of overly complex or insufficiently detailed explanations have been observed, which may affect the depth of student understanding. In addition, Ali et al. (2024) and UNESCO (2023) noted that the effectiveness of these tools as a personalized tutor depends on their guided and strategic

use, as excessive reliance may reduce students' critical engagement and limit opportunities for self-assessment and reflective thinking.

To conclude, the literature and studies suggest that even though generative AI tools increase the accessibility to information and support independent learning, their advantages do not come automatically, since they require guidance, balance, and critical engagement exercised by the learner.

1.2. Use of Generative AI Tools in Biology Class in terms of Content Creation (Table 2)

The use of generative AI tools in Biology class in terms of Content Creation obtained a general weighted arithmetic mean of 3.26, with an interpretation of Strongly Agree, indicating that learners make use of generative AI tools in producing, organizing, and presenting educational outputs. In connection to this, strong agreement emphasizes that students rely on these tools because they reduce the cognitive loads in initiating and structuring tasks, enabling them to be more focused on building their ideas and creating biology-related outputs in a more manageable and efficient manner.

It shows that the statement *"Generative AI tools provide ideas when I brainstorm for projects"* obtained the highest WAM of 3.50, with a Strongly Agree verbal interpretation. This implies that learners mostly utilize generative AI tools during the ideation stage of content creation, which is often perceived as the most challenging part of academic work. This also indicates that students' dependence on these tools for idea generation could shape how they begin and structure their academic tasks, which can potentially improve efficiency, but also indicates that their independent idea generation may be less practiced. In addition, the strong agreement across related indicators such as guiding structure, summarizing materials, and combining insights from multiple references further emphasizes that students use these tools not just for basic support but also utilize them in the process of organizing, applying, analyzing, and synthesizing biological information. Thus, this challenges the hypothesis, as the results show that students' engagement with these tools is reflected in their way of processing and understanding biological concepts, indicating that such reliance may have implications for the enhancement of their information literacy skills.

On the contrary, the statement *"Generative AI tools help me create visual or multimedia learning elements"* attained the lowest WAM of 3.03, with the verbal interpretation of Agree. This demonstrates that while students utilize AI tools extensively for text-based content creation, their use in generating visual or multimedia outputs remains limited. This may be due to students' greater familiarity with AI tools for writing-related tasks rather than for visual design, or possibly due to limitations in accessibility, skills, or perceived relevance in Biology tasks. Moreover, the relatively lower ratings in arranging information and improving coherence suggest that students may still depend on their own skills when refining and finalizing outputs. This highlights a limitation wherein, in supporting the initial content development, generative AI tools are more efficient, but they are less influential in developing students' independent content refinement, and creative presentation skills remain limited.

These findings were supported by previous literature and studies. According to Chugh et al. (2025) and The Upwork Team (2024), content creation involves using generative AI applications to create outputs such as text and images through pattern recognition of data. In relation, Kaplan and Haenlein (2018) also stated that these tools function as assistive and augmented technologies that support learners in generating ideas, organizing content, and refining outputs, allowing them to engage more efficiently in academic tasks. These emphasized how learners rely on generative AI tools to facilitate the early and organizational stages of content creation.

Similarly, Hsu (2025) highlights that these tools facilitate the process of brainstorming, structuring, and synthesizing information, which reduces the cognitive demands associated with starting tasks and enables students to focus more on developing and improving their ideas. In addition, Agarwal and Khattar (2025) revealed that students preferred to use the generative AI tools since they provide direct and relevant outputs, particularly in idea generation and content development, which enhances productivity and supports academic performance. This indicates that generative AI tools not only facilitate idea generation but also help students organize and synthesize information, which helps students to produce more coherent and structured Biology outputs.

In contrast, Tadena et al. (2025) pointed out that even though these tools facilitate idea generation and increase efficiency, there have been concerns raised about their possible implications on the independent thinking and creativity of the students. This indicates that overdependence on AI-generated content could hinder the development of thinking skills and creativity among the students. Moreover, Yan and Qianjun (2025) identified the issues related to authenticity, bias, and credibility of AI-generated output, which can affect how students evaluate and refine their outputs. Overall, this implies that even though generative AI tools help assist the initial stages and structuring of content, their influence on independent refinement, creativity, and critical evaluation may be limited when not used with sufficient caution and discernment.

1.3. Use of Generative AI Tools in Biology Class in terms of Feedback and Assessment (Table 3)

The use of generative AI tools in Biology class in terms of Feedback and Assessments has an overall weighted arithmetic mean of 3.24, which is verbally interpreted as Agree, indicating that learners generally utilize generative AI tools because they are able to support feedback and assessment processes, but to a lesser extent compared to personalized tutoring and content creation. This implies that although recognized as useful, the use of these tools remains selective rather than fully integrated, as they can serve as a support rather than the main source of evaluation. In relation, the students may still depend on teachers' validation and judgment.

In connection, the statement *"Generative AI tools help me identify concepts I have not fully understood"* had the highest WAM of 3.39, which is interpreted as Strongly Agree. This indicates that students mostly utilize generative AI tools for identifying learning gaps and clarifying misunderstandings in Biology. In addition, this suggests that students may

gradually depend on external support that could influence the continuous growth of their critical thinking and information literacy skills. Moreover, the high ratings for recommending improvements and guiding next learning steps further suggest that these tools provide immediate, specific, and actionable feedback that helps students adjust their learning strategies. Collectively, this implies that generative AI tools may reinforce learning through continuous feedback, as this can contribute to formative assessment that enables students to evaluate their understanding in real time, which challenges the hypothesis.

However, the statement *"Generative AI tools help me monitor my learning progress over time"* attained the lowest WAM of 3.05, which was verbally interpreted as Agree. This demonstrates that although students utilize AI tools for immediate feedback and assessment, their use for long-term monitoring and reflective learning remains limited. This may be because students tend to engage with AI tools for short-term academic needs, such as checking answers or improving outputs, rather than for tracking their progress over time. Additionally, the relatively lower ratings in indicators related to reflection and progress monitoring emphasize that students may still rely on their own strategies when engaging in deeper thinking processes. Overall, this highlights that in supporting immediate learning needs, generative AI tools are more effective but are less influential in promoting sustained self-regulated learning and long-term evaluation skills.

These findings are supported by Mandouit and Hattie (2023), who described feedback as information provided to learners to improve understanding and adjust learning strategies, which supports the claim that generative AI tools were utilized by the students to guide their learning process and evaluate their achievement. In relation to this, Prompiengchai et al. (2025) emphasized that during formative assessment, generative AI can provide immediate, contextualized, and personalized feedback, allowing students to identify errors and clarify misunderstandings while learning. This implies that students benefit from generative AI tools as a source of continuous feedback that supports ongoing learning adjustments in Biology.

Similarly, Ilieva et al. (2025) pointed out that the use of AI tools leads to improvements in the individualized feedback and assessment process due to the availability of real-time responses and adaptive evaluation. Additionally, these ideas are further reinforced by Andrei et al. (2025) and Milloria et al. (2024), who found that AI-assisted feedback improves students' understanding and academic performance through scaffolded explanations and immediate corrective support. Taken together, this emphasized that generative AI tools support formative assessment by assisting students in identifying learning gaps, refining their answers, and enhancing their comprehension of biological concepts through continuous and immediate feedback.

On the other hand, despite these advantages, Luo et al. (2025) present a contradiction by stating that the effectiveness of AI-based feedback depends on guided and structured implementation, as ethical considerations and proper pedagogical alignment are necessary for meaningful learning. With that, this emphasizes the contribution of generative AI tools to deeper learning and sustained improvement, which may be reduced without clear instructional integration and guidance.

Part II. Adverse Effects of Generative AI Tools on the Information Literacy of Students in Biology Learning

2.1. Adverse Effects of Generative AI Tools on the Information Literacy of Students in Biology Learning in terms of Locating Information (Table 4)

The adverse effects of generative AI tools on the information literacy of the students in Biology learning in terms of Locating Information shows that there was an agreement among respondents for all indicators, wherein it garnered an overall weighted arithmetic mean of 2.64, which is interpreted as Agree, implying that students commonly encounter challenges in locating information in their Biology learning when using generative AI tools. In relation, this suggests that the overall agreement on the use of these tools is associated with a moderate but consistent negative effect on students' ability to independently search for relevant information. This implies that while generative AI tools provide convenient access to information, they may reduce students' involvement in the effort of searching for information in Biology.

In line with this, the data indicates that students usually depend on the responses generated by AI tools as their primary source of information rather than engaging in traditional search practices such as formulating keywords, selecting appropriate sources, and navigating different platforms. The findings imply that students' dependence on AI tools may limit their exposure to diverse sources of information, which is a critical component of information literacy. Instead of consulting multiple references, students may rely on synthesized responses provided by AI, reducing opportunities to compare, verify, and contextualize information.

However, the level of agreement also indicates that these challenges are not absolute but occur to a moderate extent. This suggests that while students experience difficulties, they are still capable of locating information independently when necessary. With that, this highlights a key limitation of generative AI tools, wherein, although it helps provide immediate access to information, it may also weaken the enhancement of research skills if used extensively. This implies that the impact of AI tools is more behavioral than cognitive, influencing how often students practice information-seeking strategies rather than eliminating their capability to perform them.

These findings were supported by previous literature and studies. Haider and Sundin (2019) explained that while digital tools increase the accessibility of information, they may also reduce students' engagement in the active process of searching for information. Similarly, Dahlen and Hanson (2023) emphasized that locating information requires strategic actions such as choosing appropriate sources, refining search strategies, and navigating different platforms. These suggest that although generative AI tools make information more readily available, they may limit students' practice of fundamental information-seeking strategies.

In addition, Paycana (2025) highlighted that the way students search is strongly influenced by their interests and preferred digital platforms, suggesting that with the convenience of responses generated by AI tools, it discourages students from deeper

exploration of multiple sources. Furthermore, Zhai et al. (2024) strengthen this by pointing out that excessive reliance on AI systems encourages students to prefer quick and convenient answers, where students tend to skip essential steps such as formulating their own search queries, refining keywords, and consulting multiple sources, which ultimately weakens their ability to independently locate information. Taken together, the results show that although generative AI tools enable the students to have more access to information, they also reduce the practice of basic searching skills, leading to difficulties in independently locating accurate and relevant information.

2.2. Adverse Effects of Generative AI Tools on the Information Literacy of Students in Biology Learning in terms of Analyzing Information (Table 5)

The adverse effects of generative AI tools on the information literacy of the students in Biology learning in terms of Analyzing Information has a general weighted arithmetic mean of 2.41, which is interpreted as Disagree, indicating that the majority of respondents do not consider generative AI tools as a hindrance to their ability to analyze information. Instead, they use it more as a tool that supplements their thinking than as a replacement, allowing them to still assess or analyze the information that they receive. In line with this, the overall disagreement emphasized that students still actively engage in evaluating, interpreting, and verifying biological information even when using AI tools.

However, while the overall result shows disagreement, some specific challenges are still present. As shown in the table on the next page, the statement, *"I sometimes overlook sources when AI provides reasonable answers,"* got the highest WAM of 2.67, with the verbal interpretation of Agree. This means that students occasionally demonstrate lapses in critical evaluation, particularly in verifying the credibility of information sources, suggesting that the immediacy and convenience of responses generated by AI may influence students to engage in less rigorous analysis.

Moreover, the statement *"I accept AI-generated conclusions without logical analysis"* obtained the lowest WAM of 2.08, which was interpreted verbally as Disagree. This demonstrates that students generally do not rely on AI outputs uncritically and still exercise their own judgment when interpreting biological information. Additionally, the low ratings in blindly accepting information, ignoring inconsistencies, and allowing AI to determine what is important further indicate that students maintain a level of critical awareness and skepticism when engaging with AI-generated content. This suggests that students are still capable of recognizing the need for evaluation and are not fully dependent on AI in their analytical processes.

These findings were supported by Valmores and Acedera (2024), as they explained that analyzing information entails the capacity of an individual to evaluate, interpret, and verify content for accuracy, which was demonstrated by the students' disagreement with the overall findings. In connection to this, Del et al. (2024) stated that the students use different strategies to assess the reliability of online sources, such as examining language, references, consistency, authority, currency, and objectivity. This shows that the students still actively apply their evaluation skills when dealing with information,

indicating that the students' ability to analyze information remains intact even if they are using generative AI tools.

On the contrary, despite the overall findings, Hadinejad et al. (2025) and College et al. (2025) reported that while generative AI tools are useful and valued by the students, they still encounter issues such as unreliable information, bias, and other risks. This indicates that although students generally maintain their evaluation skills, there are instances wherein, because of the use of AI, it influences their evaluation practices, leading them to occasionally miss checking the sources carefully. In line with this, Pitts et al. (2025) found that students express significant concern about distinguishing between man-made and AI-generated work, especially when original outputs are mistakenly identified as AI-created. This means that although the students are knowledgeable about the necessity of evaluating information, difficulties in identifying the reliability of content created by AI due to overreliance may affect how consistently and deeply the students analyze information, which can eventually lead to weak evaluation skills. Therefore, the overall result implies that students' information literacy skills remain largely intact in terms of analyzing information. But there are still signs that they may engage more or less in-depth analysis of information as a result of frequent usage of generative AI tools.

2.3. Adverse Effects of Generative AI Tools on the Information Literacy of Students in Biology Learning in terms of Responsible Use of Information (Table 6)

The adverse effects of generative AI tools on the information literacy of students in Biology learning in terms of Responsible Use of Information shows that the respondents did not agree on all of the statements, resulting in the overall weighted arithmetic mean of 2.16, which is interpreted as Disagree, indicating that even using AI tools, the students continue to observe ethical practices such as proper citation, verification of content, and academic integrity adherence. This implies that generative AI tools do not replace students' sense of responsibility but rather function as supplementary resources that remain subject to students' judgment and ethical awareness.

In connection, the consistent low ratings across indicators related to plagiarism, citation, and accuracy suggest that students are actively engaging in reviewing and validating AI-generated content before using it in their academic work. This means that students exercise control over how information is used, reflecting a conscious effort to align their practices with academic standards and not rely passively on AI outputs. However, despite the overall disagreement, the results also suggest that responsible use is not entirely free from challenges.

Moreover, the moderate levels of disagreement across some indicators imply that there are occasional inconsistencies in how ethical practices are applied. This could be due to various aspects, including accessibility to AI-generated content, time constraints, or a lack of knowledge on the ethical implications of using AI. As a result, while students generally demonstrate responsible behavior, these practices may not always be consistently or deeply applied across all situations. This highlights a subtle limitation where generative AI tools do not directly weaken students' ethical practices but may create conditions where responsibility can be occasionally overlooked. It suggests that

the responsible use of information is influenced more by students' internal values, academic training, and awareness rather than by the mere presence of AI tools.

Supporting this, Du (2024) described that the responsible use of information is not just about finding, accessing, and processing data but also about being aware of its legal and ethical implications. In connection with this, although the results in the first variable showed that students have weaknesses in locating information and some risks in their analytical skills in the second sub-variable, the overall results in this sub-variable indicate that the students still maintain their ability to use information responsibly. In the same way, Mills and Gutierrez (2025) emphasized that information literacy is not limited to technical competence in using digital tools, but it also requires ethical awareness and critical use of these tools. This is reflected in the overall results, where despite weaknesses in certain skills such as locating information, the respondents, particularly the STEM students, still demonstrated that they were aware and capable of using generative AI tools appropriately.

Similarly, as emphasized by Ariones et al. (2024) and Saude (2024), responsible use of generative AI depends on guidance, ethical awareness, and accountability. This explains why students continue to act responsibly even when using AI, as they are still guided by their understanding of what is right and wrong. This implies that AI does not remove responsibility from students, but instead, they remain in control of how they use information. Following this, Dhar and Gayan (2022) reinforce this, noting that many students recognized instances of plagiarism and were familiar with citation standards, indicating a strong foundation in academic integrity, which helps explain why the respondents did not exhibit negative or unethical behavior.

In contrast, Santos et al. (2024) noted that while AI tools improve research, comprehension, and content creation, they also introduce concerns such as overreliance on the tool, reduced originality, and potential issues of fairness in academic work. This contradicts the findings of the present study, which indicates that students remain capable of critically evaluating and responsibly using AI-generated information.

Taken together, this shows that students still demonstrate careful evaluation, proper review, and adherence to academic standards despite the ease of use and accessibility to AI-generated content.

Part III. Significant Relationship Between the Usage of Generative AI Tools and the Information Literacy of the Students in Biology

3. Significant Relationship Between the Usage of Generative AI Tools and the Information Literacy of the Students in Biology (Table 7)

A two-tailed correlation test was employed in the study, since this allows one to identify whether a correlation coefficient is significantly different from zero by examining the potential for a positive or negative relationship in both directions (UCLA, 2021). This was appropriate for the study, as the effects of generative AI tools on information literacy are not predetermined, which can ensure that the data is objectively analyzed.

The table shows that in terms of locating information, all three areas of the use of generative AI tools show a statistically significant relationship. In particular, feedback and assessment ($r = 0.324$, $p = 0.000$) showed a stronger relationship, followed by content creation ($r = 0.246$, $p = 0.004$), while personalized tutoring ($r = 0.198$, $p = 0.021$) shows a weaker but still significant relationship. However, although the correlations are positive within this study, they indicate potential adverse effects. In line with this, the stronger relationships indicate that AI-generated feedback may reduce the need for students to revisit and verify sources, which can reinforce passive learning habits. Similarly, when the students depend on these tools to produce content, the responsibility of locating relevant information is shifted from the learner to the tool.

This was supported by Zhai et al. (2024), who explained that excessive reliance on AI systems encourages students to prefer quick and convenient answers, reducing their tendency to formulate their own search queries, refine keywords, and consult multiple sources. Likewise, Divekar et al. (2025) stated that while generative AI tools assist in academic tasks, they function primarily as supplementary tools, implying that overdependence may shift the responsibility of locating information away from the learner. Overall, this indicates that as the students increase their use of these tools, this could result in overdependence, which reduces the ability of the students to search for information independently, such as identifying appropriate keywords, selecting reliable sources, and navigating different information platforms.

On the other hand, among the three areas pertaining to the use of generative AI tools and analyzing information, only feedback and assessment ($r = 0.192$, $p = 0.025$) show a statistically significant connection. This indicates that the use of AI tools for evaluative purposes may influence analytical thinking. In essence, dependency on feedback from AI systems could reduce the ability of students to engage in higher-order thinking skills such as comparing multiple sources, identifying biases, and critically examining the accuracy and relevance of information. This was aligned with Tian and Zhang (2025), who revealed that due to reduced cognitive engagement, lower levels of critical thinking are substantially correlated with greater dependence on AI tools. Similarly, Rahyuni Melisa et al. (2025) emphasized that over-reliance could impair students' capacity to think independently and assess themselves, even though generative AI tools can support analytical processes. This implies that instead of actively analyzing content, students may accept AI-generated evaluations without deeper analysis, which can lead to reduced critical thinking practice.

Moreover, the data demonstrates that there is no significant relationship found between the responsible use of information and the use of generative AI tools. This means that the use of generative AI tools does not strongly influence the adverse effects concerning the responsible use of information. However, this does not mean that there are no negative effects at all. This only means that the effects are not strong enough to become statistically significant.

In support of this, responsible information practices are not automatically developed through the usage of AI applications, as this requires learners to consciously apply ethical standards and accountability, along with proper citation (Ariones et al.,

2024; Du, 2024; Mills & Gutierrez, 2025). In line with this, Johri et al. (2024) asserted that students often possess an incomplete understanding of its implications, although they frequently use these tools for school work. Similarly, Saúde (2024) noted that AI usage alone does not directly shape ethical behavior, as the effectiveness in promoting responsible practices depends on proper guidance. Furthermore, this literature indicates that responsible use of information is shaped more by ethical awareness and critical judgment than by the use of such tools, resulting in no significant correlation among the variables.

Conclusions

Following data analysis, the study's findings have led the researchers to conclude that the use of generative AI tools in biology class is highly evident among the respondents, particularly in personalized tutoring, which obtained the highest ratings of utilization, indicating that generative AI tools are primarily used to enhance conceptual understanding and cognitive engagement. While feedback and assessment got the lowest ratings of utilization, emphasizing that these tools are less influential in promoting self-reflection and awareness. This suggests that students use generative AI technologies more frequently for instant academic support rather than for deeper self-assessment processes.

Furthermore, in terms with the generative AI tools' adverse effects on students' information literacy, it is most evident in locating information, suggesting that excessive dependence on these tools may decline the students' independent information searching skills and decrease engagement with diverse sources. On the contrary, the responsible use of information showed the least evident effects among the respondents, indicating that students generally maintain responsible and ethical practices when using generative AI tools. This emphasized that the use of these tools may affect procedural skills like searching for information, but it does not significantly lessen students' critical judgment or ethical responsibility.

With regard to the relationship between the variables, a significant relationship was found between the use of generative AI tools and locating information, which leads to the rejection of the null hypothesis for this variable. For analyzing information, only the dimension of feedback and assessment showed a significant relationship. Therefore, the null hypothesis is partially rejected. Meanwhile, no significant relationship was found between the use of generative AI tools and the responsible use of information, which leads to the acceptance of the null hypothesis. This means that even the increased use of generative AI tools is associated with challenges in locating and analyzing information, but it does not significantly affect students' ethical and responsible use of information, which remains guided by their internal awareness and academic training.

Finally, the study's findings led the researchers to produce a set of guidelines in the form of an educational video entitled "The GUIDE: Grounding Users in the Informed, Disciplined, and Ethical Use of Generative AI Tools for Biology." This educational video includes guidelines, key principles, and practical strategies that help students properly utilize generative AI tools, particularly in improving their capability to locate and analyze

information while reinforcing responsible and ethical use, as found in the study's findings. It also aims to reduce students' overreliance on generative AI tools by promoting independent learning, critical thinking, and making well-informed decisions in Biology.

Recommendations

Based on the findings and conclusions obtained from the study, the following recommendations are made.

First, regarding with the Grade 11 STEM students, they are encouraged to practice their independent skills in terms of locating information by consulting textbooks, journals, and other credible sources before using generative AI tools. They are likewise encouraged to verify AI-generated responses, develop their own search strategies, and ensure that all outputs are reviewed, understood, and properly rewritten to strengthen their skills in locating and analyzing information.

Then, the Science teachers are advised to provide learning activities that require students to utilize multiple sources of information instead of solely depending on generative AI tools. They may also help the students in assessing the accuracy and credibility of information and incorporate tasks that promote critical thinking and explanation. Also, one should model the proper and ethical use of generative AI tools and establish clear guidelines for their use in academic work.

At the school level, school administrators are encouraged to carry out training programs and seminars that encourage the responsible and efficient application of generative AI tools. They may also ensure access to reliable academic resources and reinforce policies related to academic integrity. In addition, the integration of the developed educational material is also recommended to support students in improving their information literacy skills.

Finally, future researchers are encouraged to explore additional approaches that can enhance students' ability to locate and analyze information while using AI tools. They may also examine other variables, subject areas, or educational levels to further understand the effects of generative AI tools on students' learning and information literacy.

Compliance with Ethical Standards

The researchers followed ethical principles throughout the conduct of the study. In particular, before data collection, consent letters were handed over to the respondents and their parents asking for their permission to be part of the study. The participation was voluntary, and the respondents had the right to pull out anytime without facing any form of penalty. Moreover, the privacy of the respondents was maintained, and their responses remained confidential. Also, in line with the Data Privacy Act of 2012, the information gathered will be used for academic and research purposes only.

Furthermore, the researchers ensured that the results were presented honestly and fairly, without intentionally changing or favoring any findings. The data were analyzed based on the respondents' actual answers, and the results were used only for the purposes of research. In relation, all sources used in the study were properly cited to avoid plagiarism. The researchers also declare that there was no conflict of interest in conducting the study. Additionally, generative AI tools were used to help improve the flow and organization of the discussion, making the ideas easier to follow and understand. They were also used to help organize the researchers' relevant experiences and relate them to the focus of the study. However, the researchers remained responsible for reviewing the content, checking its accuracy, and ensuring that the final paper reflected their own understanding and the actual findings of the research.

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REFERENCES

Abdullah Abdulaziz Bawazir, Kamal, A., Lean, G. L., Lee, L., Ng Seong Kai, Sarina Mohamad Nor, & Aina, P. (2023). Factors Affecting Consumer Acceptance of E-Menu in The Klang Valley Restaurant Sector in Malaysia. International Journal of Academic Research in Business & Social Sciences, 13(6). https://doi.org/10.6007/ijarbss/v13-i6/17108

Agarwal, S., & Khattar, V. (2025). Use of generative AI among high school students. Journal of Student Research, 14(1). https://doi.org/10.47611/jsrhs.v14i1.8520

Aligato, W., & Saligumba, I. (2025). The Use of Generative AI Tools and Their Role in Science Learning among Senior High School Students. International Journal for Multidisciplinary Research, 7(3). https://doi.org/10.36948/ijfmr.2025.v07i03.44773

Ali, O., Murray, P. A., Momin, M., Dwivedi, Y. K., & Malik, F. T. (2024). The Effects of Artificial Intelligence Applications in Educational settings: Challenges and Strategies. Technological Forecasting and Social Change, 199(123076), 123076–123076. https://doi.org/10.1016/j.techfore.2023.123076

Almasri, F. (2024). Exploring the impact of artificial intelligence in teaching and learning of science: A systematic review of empirical research. Research in Science Education, 54(1). https://doi.org/10.1007/s11165-024-10176-3

Andrei, N., De, C., Francisco, L. M., Hernandez, N., Lei, F., Marie, S., & Sison, L. B. (2025). The Effect of Chatgpt 3.0 as a Personalized Learning Tool in Answering Atomic Structure Assessments. American Journal of Education and Technology, 4(3), 1–11. https://doi.org/10.54536/ajet.v4i3.4700

Ariones, J. J., Keith, T., Ducusin, R. F., Leah, A., Reola, C. R., & Delizo, C. B. (2024). Responsible Use of Artificial Intelligence in Learning among Senior High School Students. Ascendens Asia Journal of Multidisciplinary Research Abstracts, 7(3). https://ojs.aaresearchindex.com/index.php/AAJMRA/article/view/14626

Bailey, E. (2024, August 27). AI in Literacy Education: Potentials and Pitfalls. Rif.org. https://www.rif.org/news-and-stories/blog-posts/ai-literacy-education-potentials-and-pitfalls

Barrickman, N., Bell, K., & Cowan, C. (2026). Chapter 1: The Science of Biology. Human Biology; Pressbooks. https://slcc.pressbooks.pub/humanbiology/chapter/chapter-1/

Binhammad, M. H. Y., Othman, A., Abuljadayel, L., Mheiri, H. A., Alkaabi, M., & Almarri, M. (2024). Investigating how generative AI can create personalized learning materials tailored to individual student needs. Creative Education, 15(7), 1499–1523. https://doi.org/10.4236/ce.2024.157091

Bluechip Technologies Asia. (2025, June 2). Introduction in traditional classrooms or online learning environments, students often struggle to keep up due to varying learning speeds, gaps in foundational knowledge, or lack of one-on-one guidance. These challenges can lead to frustration, decreased motivation, and uneven academic performance.

Bogalin, V., Zvavahera, P., Aquino, E., Ramamurthy, V., Lopez, M., & Scaria, J. (2025, June). Assessing the influence of generative AI tools on students' learning outcomes in institutions of higher learning. IBSU. https://ibsu.ac.pg/assessing-the-influence-of-generative-ai-tools-on-students-learning-outcomes-in-institutions-of-higher-learning/

Brodowicz, M. (2024, March 1). Descriptive Correlational Design in Research. Aithor.com; Aithor. https://aithor.com/essay-examples/descriptive-correlational-design-in-research

Chugh, R., Turnbull, D., Morshed, A., Fariza Sabrina, Azad, S., Rashid Md Mamunur, Shahriar Kaisar, & Subramani, S. (2025). The Promise and Pitfalls: A Literature Review of Generative Artificial Intelligence as a Learning Assistant in ICT Education. Computer Applications in Engineering Education, 33(2). https://doi.org/10.1002/cae.70002

College, Ronar, M., Bacarrisas, H. P., & General. (2025). Higher education students' information literacy skills in engaging with AIgenerated content. International Journal of ADVANCED and APPLIED SCIENCES, 12(12), 1–8. https://doi.org/10.21833/ijaas.2025.12.001

Dahlen, S. P. C., & Hanson, K. (2023). In their words: Student reflections on information-seeking behaviors. The Journal of Academic Librarianship, 49(4), 102713. https://doi.org/10.1016/j.acalib.2023.102713

Del, L. N., Abuzo, C. S., Jay, J., & Jelord Lufranco. (2024). An Action Research Evaluating Artificial Intelligence (AI) Consumption among Learners of San Vicente National High School as Online

Scaffold to Academic Endeavor: Experiences and Practices. Randwick International of Education and Linguistics Science Journal, 5(3), 804–809. https://doi.org/10.47175/rielsj.v5i3.1042

DepEd Quezon. (2023). DepEd Quezon. Depedquezon.com.ph. https://depedquezon.com.ph/data/schools/pubshs2

Dhar, P., & Gayan, M. A. (2022). Academic Integrity, Information Use and Information Literacy in the Digital Environment: A study from An Ethical use Perspective Academic Integrity, Information Use and Information Literacy in the Digital Environment: A study from An Ethical use Perspective. 13th International CALIBER -2022. https://www.researchgate.net/publication/377555345_Academic_Integrity_Information_Use_and_Information_Literacy_in_the_Digital_Environment_A_study_from_An_Ethical_use_Perspective_Academic_Integrity_Information_Use_and_Information_Literacy_in_the_Digita

Diaz, D., Funa, A., & Gabay, R. A. (2025). ChatGPT in STEM Classrooms: Students' Perceptions of Interest, Academic Proficiency, and Learning Independence. Journal of Basic Education Research, 6(3), 470–480. https://doi.org/10.37251/jber.v6i3.2096

Divekar, R. R., Gonzalez, L., Guerra, S., Boos, N., & Divekar, R. (2025). Can Generative AI Replace Search Engines for Learning? Understanding Student Preferences, Use and Perceived Proficiency in Using AI. TechTrends. https://doi.org/10.1007/s11528-025-01095-9

Du, E. (2024). Information Literacy: Leveraging AI technology for teaching academic integrity and anti-plagiarism practices. Georgia Southern Commons. https://digitalcommons.georgiasouthern.edu/gaintlit/2024/2024/3/

Esponilla II, F. E., Alinsunod, J. P., De, M., & Espinas, A. L. (2025). Digital Literacy Skills and Academic Performance on Online Learning Environments of State Universities and Colleges in the Philippines. https://doi.org/10.21203/rs.3.rs-8284955/v1

Galagala, M. R., & Bacarrisas, H. P. (2025). Higher education students' information literacy skills in engaging with AI generated content. International Journal of ADVANCED and APPLIED SCIENCES, 12(12), 1–8. https://doi.org/10.21833/ijaas.2025.12.001

Glance. (2025, April 30). Generative AI Tools: Explore Image, Text, and Video Models. Glance.com; Glance. https://glance.com/us/blogs/glanceai/ai-trends/generative-ai-tools-types

Grájeda, A., Burgos, J., Olivera, P. C., & Sanjinés, A. (2023). Assessing student-perceived impact of using artificial intelligence tools: Construction of a synthetic index of application in higher education. Cogent Education, 11(1). https://doi.org/10.1080/2331186x.2023.2287917

Hadinejad, N., Sperling, K., & McGrath, C. (2025). Generative AI Chatbots in Higher Education: Student experiences and perceived ethical challenges. Computers and Education Open, 100311. https://doi.org/10.1016/j.caeo.2025.100311

Haider, J., & Sundin, O. (2019). Invisible Search and Online Search Engines. https://doi.org/10.4324/9780429448546

Harvard University Information Technology. (2023). Generative Artificial Intelligence (AI). Harvard.edu. https://www.huit.harvard.edu/ai

Henson, B. (2021, October 25). Guides: Media Literacy: Information Literacy Defined. Guides.library.unt.edu. https://guides.library.unt.edu/medialiteracy/information-literacy-defined

Hsu, H.-P. (2025). From Programming to Prompting: Developing Computational Thinking through Large Language Model-Based Generative Artificial Intelligence. TechTrends. https://doi.org/10.1007/s11528-025-01052-6

Ignas, A. L. (2025). Exploring the Experiences of Tertiary students in using Artificial Intelligence (AI). Social Science and Humanities Journal, 9(05), 7997–8008. https://doi.org/10.18535/sshj.v9i05.1833

Ilieva, G., Yankova, T., Ruseva, M., & Stanimir Kabaivanov. (2025). A framework for generative AI-driven assessment in higher education. Information, 16(6), 472–472. https://doi.org/10.3390/info16060472

Jeffery, E., Nomme, K., Deane, T., Pollock, C., & Birol, G. (2016). Investigating the Role of an Inquiry-Based Biology Lab Course on Student Attitudes and Views toward Science. CBE—Life Sciences Education, 15(4), ar61. https://doi.org/10.1187/cbe.14-11-0203

Kaplan, A., & Haenlein, M. (2018). Siri, siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. Business Horizons, 62(1), 15–25. https://doi.org/10.1016/j.bushor.2018.08.004

Lawton, G. (2024). What is Gen AI? Generative AI explained. Search Enterprise AI; TechTarget. https://www.techtarget.com/searchenterpriseai/definition/generative-AI

Legas, M. D., & Mamaril, J. C. (2025). AI in education: Impact on learning experiences and outcomes at new lambunao integrated school. Asian Journal of Multidisciplinary Studies, 8(1), 1–5. https://orcid.org/0000-0001-9310-2839

Li, N. H., & Balinas, E. S. (2025). The Impact of Generative Artificial Intelligence on University Information Literacy Education: A Systematic Review from Challenges to Changes. International Journal of Latest Technology in Engineering

LunarTech AI. (2025, January 18). Personalized learning systems powered by AI. Lunartech.ai. https://www.lunartech.ai/blog/personalized-learning-systems-powered-by-ai

Luo, J., Zheng, C., Yin, J., & Teo, H. H. (2025). Design and Assessment of AI-based Learning Tools in Higher education: a Systematic Review. International Journal of Educational Technology in Higher Education, 22(1). https://doi.org/10.1186/s41239-025-00540-2

Mandouit, L., & Hattie, J. (2023). Revisiting “The Power of Feedback” from the perspective of the learner. Learning and Instruction, 84(84). https://doi.org/10.1016/j.learninstruc.2022.101718

Mapúa University. (2025, February 20). How an AI personal tutor can help you in your studies. Mapua.edu.ph. https://www.mapua.edu.ph/blog/how-an-ai-personal-tutor-can-help-you-in-your-studies

Martinez, A. L. (2026, January 11). DepEd targets AI literacy, training for 1.5 million Filipinos in 2026 - BusinessWorld Online. BusinessWorld Online. https://www.bworldonline.com/education/2026/01/11/723422/deped-targets-ai-literacy-training-for-1-5-million-filipinos-in-2026/?

Milloria, B. R., Marzon, A. M., & Derasin , L. M. (2024, June 1). Investigating ai-integrated instruction in improving academic performance of senior high school students in the philippines. ResearchGate. https://doi.org/10.13140/RG.2.2.36797.27366

Mills, K. A., & Gutierrez, A. (2025). Critical Literacy in an AI World. Routledge.

Miranda, J. P., Bansil, J. A., Fernando, E., Gamboa, A., Hernandez, H., Cruz, M., Roque Francis Dianelo, Gonzales, D., & Penecilla, E. (2024). Prevalence, Devices Used, Reasons for Use, Trust, Barriers, and Challenges in Utilizing Generative AI among Tertiary Students. 1–6. https://doi.org/10.1109/ictiia61827.2024.10761175

Moquin, S. (2025, March 10). Generative AI in Education: How AI is Transforming Learning. Enrollify.org. https://www.enrollify.org/blog/generative-ai-in-education

Ortiz, O., dela Cruz, J. M., Ali, A., & Viana, A. (2025). Artificial intelligence in the traditional teaching and learning landscape: Cases from selected secondary schools in the philippines. Technologique, 4(1), 19–24. https://doi.org/10.62718/vmca.tech-gjtdsi.3.1.sc-0225-005

Paycana, M. F. (2025). Search Habits, Strategies, and Criteria to Filter the Online News and News Outlets of the College Students: Basis for Media and Information Literacy Program. Journal of Information Systems Engineering and Management, 10(43s), 207–213.https://doi.org/10.52783/jisem.v10i43s.8356

Pitts, G., Marcus, V., & Motamedi, S. (2025). Student Perspectives on the Benefits and Risks of AI in Education. ArXiv.org. https://arxiv.org/abs/2505.02198

Prompiengchai, S., Narreddy, C., & Joordens, S. (2025, June 2). A practical guide for supporting formative assessment and feedback using generative AI | SCALE initiative. Stanford.edu. https://scale.stanford.edu/ai/repository/practical-guide-supporting-formative-assessment-and-feedback-using-generative-ai?

Rahyuni Melisa, Ashadi Ashadi, Triastuti, A., Hidayati, S., & Zaki Al Fuad. (2025). Critical Thinking in the Age of AI: A Systematic Review of AI’s Effects on Higher Education. Educational Process International Journal, 14(1)

Saarela, M. (2026, February 25). Can generative AI really improve language learning? What 51 studies tell us. Research Communities by Springer Nature; Springer Nature. https://communities.springernature.com/posts/can-generative-ai-really-improve-language-learning-what-51-studies-tell-us

Santos, M. J. D., Roldan, C. B. B., Pepito, G. T., & Lim-Cheng, N. R. T. (2024). Integrity in the Age of AI: Ethical Considerations of ChatGPT Use Among De La Salle University Senior High School Students. Animo Repository. https://animorepository.dlsu.edu.ph/conf_shsrescon/2024/paper_csr/3/

Saúde, S. (2024). Impacts of Generative Artificial Intelligence in Higher Education: Research Trends and Students' Perceptions. Social Sciences, 13(8), 1–19. https://ideas.repec.org/a/gam/jscscx/v13y2024i8p410-d1451498.html

Sevillano, S. (2026, February 25). DepEd allows responsible AI use among learners, teachers nationwide. Philippine News Agency. https://www.pna.gov.ph/articles/1269776

Sreekumar, D. (2023, March 23). What Is Quantitative Research? Definition, Methods, Types, and Examples | Researcher.Life. Researcher.life. https://researcher.life/blog/article/what-is-quantitative-research-types-and-examples/

Tadena, E. B., Libron, C. I., Aquino, J., Aringo, S. C., Buhian, K. B., Dean, J. K., Manajero, I. P., & Tulang, G. A. (2025). Unveiling the matrix: Lived experiences of senior high school STEM pre-computer studies learners on AI- generated audio- visual contents. International Journal of Multidisciplinary Educational Research and Innovation, 3(2), 1–1. https://www.ejournals.ph/article.php?id=29155

Tetzlaff, L., Schmiedek, F., & Brod, G. (2020). Developing Personalized Education: A Dynamic Framework. Educational Psychology Review, 33(3), 863–882. https://doi.org/10.1007/s10648-020-09570-w

The Upwork Team. (2024, December 18). What Is AI Content Creation, and Why Does It Matter? Upwork.com; Upwork. https://www.upwork.com/resources/what-is-ai-content-creation

Tian, J., & Zhang, R. (2025). Learners' AI dependence and critical thinking: The psychological mechanism of fatigue and the social buffering role of AI literacy. Acta Psychologica, 260, 105725. https://doi.org/10.1016/j.actpsy.2025.105725

UCLA. (2021).FAQ: What are the differences between one-tailed and two-tailed tests? Stats.oarc.ucla.edu. https://stats.oarc.ucla.edu/other/mult-pkg/faq/general/faq-what-are-the-differences-between-one-tailed-and-two-tailed-tests/

UNESCO. (2023). Guidance for generative AI in education and research. Unesco.org. https://unesdoc.unesco.org/ark:/48223/pf0000386693

Valmores, K. K. D., & Acedera, A. P. (2024). Influence of Information Needs and Information Seeking Behavior on Graduate School Students' Literacy Skills. British Journal of Multidisciplinary and Advanced Studies, 5(2), 10–23. https://doi.org/10.37745/bjmas.2022.0465

Vijayamohan, P. (2022, January 22). Purposive Sampling 101: Definition, Types, And Examples. SurveySparrow. https://surveysparrow.com/blog/purposive-sampling/

Yan, Z., & Qianjun, T. (2025). Integrating AI-generated content tools in higher education: A comparative analysis of interdisciplinary learning outcomes. Scientific Reports, 15(1). https://doi.org/10.1038/s41598-025-10941-y

Zhai, C., Wibowo, S., & Li, L. D. (2024). The effects of over-reliance on AI dialogue systems on students' cognitive abilities: a systematic review. Smart Learning Environments, 11(28), 1–37. https://doi.org/10.1186/s40561-024-00316-7

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