



Exploring the Perception of Science Teachers in Integration of AI in Biology Education: Literature Review

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ABSTRACT

This study explores the perception of science teachers on the integration of Artificial Intelligence (AI) in Biology education through a literature review approach. It aims to identify the benefits, challenges and applications of AI tools as perceived by science teachers. The review analyzed studies sources via SciSpace, highlighting teacher attitudes, AI tool types and the barriers to implementation. The research found generally positive perceptions toward AI in Biology, especially regarding improved lesson planning, visualization and adaptive learning. However, challenges, such as, technical limitations, curriculum alignment and lack of professional development remain. The findings underscore the need for targeted teacher training and policy reform to support meaningful AI integration Biology instruction.

INTRODUCTION

Artificial Intelligence (AI) makes the life of people easier to think and understand ideas. Rashid & Kausik (2024) mentioned that it encompasses machine-displayed intelligence that performs human cognitive function. Since, it is a system that simulate how human analyze data, recognize pattern and understand the natural language. AI has been utilized in the different sectors of the society that help and guide people to work effectively and efficiently. Naqbi et al. (2024) reported that the integration of AI in various organization marks a positive skewed in digital transformation and enhanced creativity. Also, it increases productivity work and produce accurate technical reports.

One of the sectors in the society that AI is being utilized is in education. Gocen & Aydemir (2020) mentioned that AI for education involves excitement and promising development for schools. Artificial Intelligence in education (AIED) offers a wide range opportunities that enhance the learning experiences of the students, improve student outcomes and promote inclusion (Eden et al., 2024). Moreover, AI in education help teachers and students better face and use AI technology in the teaching and learning process. Also, it improves teachers' teaching quality and student's learning method since the student's learning styles is more diverse and personalized (Zhang & Aslan, 2021; Huang et al., 2021; Harry & Sayundin, 2023).

However, Eden et al. (2024) mentioned that there must be a careful navigation with the significant challenges and ethical consideration to ensure the responsible and equitable use of AI technologies. With this, there must be careful management with the development of AI regards with content and its effect. Still, it is not a cure for everything or an improvement that will bring absolute good (Gocen & Aydemir, 2020).

AI has the potential to revolutionize science instruction by offering fresh approaches to student and engagement and improving learning outcomes (Akhmadieva et al., 2023; Joseph & Uzundu, 2024). To support this, Almasri et al. (2024) elaborated that AI in science education established positive impacts on student learning outcomes. It encourages the students to participate in the educational process, enhances comprehension of the subject and boost motivation. Xu et al. (2022) discuss that AI has a potential to transform the instructor-student relationships in STEM education from the instructor-directed to student-centered learning. Further, Leon et al. (2025) noted that AI holds potential to revolutionize STEM education through adaptive learning platform, virtual laboratories and intelligent tutorial systems.

On the other hand, Almasri et al. (2024) mentioned problem encountered using AI in science education, such as, inability to understand the subject matter or content, inability adjust to various educational context and variation in performance between various AI models. The educators need to be aware of the possible risk potential and ethical issues using AI in the science classroom (Zhai et al., 2021; Akhmadieva et al., 2023; Joseph & Uzundu, 2024). Align with this, instructors need to take agency to promote the pedagogical designs and strategies when applying AI technology to achieve high quality of AI-STEM

education. Since the success of these technologies is dependent on how it is implemented and governed (Xu et al., 2022; Leon et al., 2025).

There are recommendations to improve the implementation of AI in science education. Joseph & Uzundu (2024) recommended that to optimize the use of AI in STEM education, there must be an investment in professional development for educators to enhance their AI competencies, ensure equitable access to AI tools across educational contexts and foster international collaboration and innovative solutions. Also, Leon et al. (2025) mentioned to focus with the discussion of policy development and open-source initiative to democratize AI-based STEM education, specifically on continuous research, evaluation and adaptation.

There are limited research regards with integration of AI in science education. In support, Akhmadieva et al. (2023) evaluated that there is a need for continued research on AI in Science Education and discover the capacity of AI in enhancing science education and demanding situation in implementing it. Align with this, Aripin et al. (2024) emphasized that AI in biology education has been mapped out but there remain fragments need for more comprehensive synthesis. Also, Almasri et al. (2024) mentioned that one of the science contents less studies is biology which is underscored the uneven subject distribution and call for more reviews on biology-related AI integration.

It is evident that integration of AI in science education remains a developing field with existing studies, still limited scope and depth. With the initial efforts have explored its potential, there are other factors needed to be discovered and discuss, such as how AI can enhance science learning and address the challenges of its implementation. In the context in biology education, there are lack of research that leaves a significant gap in understanding the specific ways AI can be effectively applied to this discipline. The uneven focus on different science discipline highlights the need for more targeted investigations with the integration of AI in biology.

THEORETICAL REVIEW

AI can transform teaching and learning process. It can help and guide both teachers and student as the persona in the process of learning. Alkan (2024) and Bah (2024) highlighted that AI improve personal and adaptive learning pathways that assess the needs of the individual, provide personal materials and monitor performance.

For teachers, Duarte et al (2023) stated that AI can support and improve teaching efficiency. It makes the lesson to be adaptive to needs and implemented curriculum design (Cela et al, 2024). It automates the administrative tasks of teachers (Leong, 2025; Bah, 2024; D'Souza, 2024; Utepbergenova, 2024). It automates assessment and feedback (Leong 2025; Boumediene et al, 2024). It improves classroom management and student engagement (Boumediene et al, 2024; Utepbergenova, 2024). It is a virtual assistant in every task (Bah, 2024). It shows educational analytics and learning for teachers (Leong et al, 2025; Cela et al., 2024).

For students, Bah (2024) and Utepbergenova (2024) elaborated that AI can enhance learning opportunities and increase the engagement of the students. It is expected that most of the students will have a better learning outcome with the real-time feedback from teachers (Boumediene et al, 2024; Duarte et al, 2023). It assists the students to have intelligent tutoring system that they have a partner for exploring new ideas and concepts (Bah, 2024; Utepbergenova, 2024). It has adaptive platforms since AI adjust to the needs of the individual's needs D'Souza (2024).

Still, there challenges that can be encounter as AI is being implemented in the field of education. There are issues needed to be address, such as, data privacy concerns (Bah, 2024; Cela et al., 2024; Duarte et al, 2023), ethical concerns (Leong et al, 2025; Bah, 2024), algorithmic bias (Cela et al, 2024; Duarte, 2023), data quality (Duarte et al, 2023), equity issues (Utepbergenova, 2024) and future trends (Leong et al, 2025).

AI is increasingly integrated and utilize in science education which shows that it is currently developing (Arici, 2024; Erduran, 2023). Almasri (2024) elaborated that AI in science education enhance the learning outcomes, assessment methods and administrative process that improves pedagogical practices and student performance.

For science teachers, Akhmadieva et al (2023) mentioned that AI in science education enhances and empowers teachers to provide personalized learning pathways and data-driven insights. Align with this, Erduran (2023) added that there generating tools for science teaching & learning (Yılmaz, 2024) and assessment (Hadley-Huley et al, 2024; Heeg et al, 2023).

For students in a science class, Kotsis (2024) and Adli et al. (2024) supported that AI in science education offers personalized learning experiences that enhances student motivation, engagement and understanding complex concepts in science through tailored materials. Moreover, Hadley-Huley et al (2024) and Yılmaz (2024) explained that AI can be an aid in a student-centered learning that it helps and guide students for problem solving and develop critical thinking skills (Anand, 2024; Erduran et al, 2024; Heeg et al, 2023).

However, there are constraints and recommendation needed to take note of integrating AI in science education. Alamsari (2024), Anand (2024) and Yılmaz (2024) listed financial constraint, infrastructure, data privacy and ethics. Adli et al. (2024) and Erduran (2023) included that there will be reduced teacher-student interaction and too much dependence on technology. Also, there is a need of teaching training for effective AI integration (Adli et al, 2024; Anand, 2024; Yılmaz, 2024).

With this, Erduran et al (2024) emphasized that AI's role in science education is crucial for adapting to evolving scientific landscapes. Further, Herdliska (2024) and Erduran (2023) noted that AI tools will have an adaptive pedagogical strategy that will tailor the diverse learning needs trajectories of the students align with educational objectives and expected required skills for the students to develop. Also, AI-based gradually move to a transformative educational approach that focuses on scientific inquiry.

Conceptual Framework

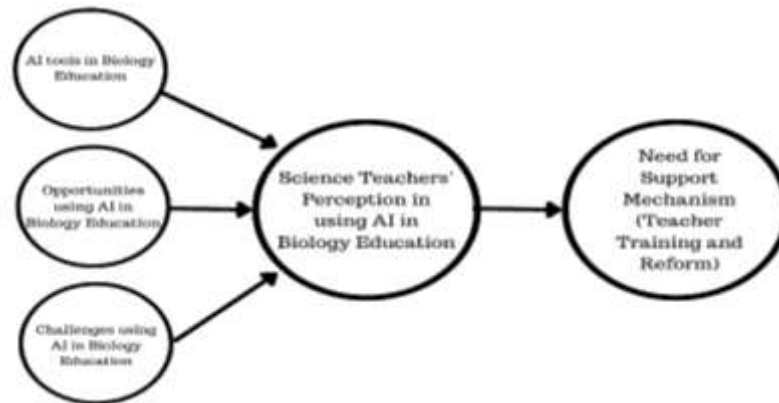


Figure 1. The conceptual framework of Exploring the Perception of Science Teachers in Integration of AI in Biology Education

The illustration 1 is the conceptual framework of the study that illustrates how science teachers' perception of using Artificial Intelligence (AI) in Biology education is shaped by three factors - types of AI tools available, the opportunities these tools provided, and challenges encountered in their implementation.

These factors influence the over-all perception of science teachers regarding AI in Biology education. This perception points to the need for support mechanisms, specifically teacher training and policy reform, to ensure the effective and sustainable use of AI tools in Biology education.

METHODOLOGY

This research utilized the literature review method. It is a comprehensive analysis of existing literature on a specific topic that serves to identify gaps, synthesize information and provide context for new research endeavors. Further, it is a summary of existing literature on a topic, identify practical and theoretical problems and guiding new research projects by filling gaps in the literature. (Fang, 2021; Hazari, 2023).

The literature review technique includes several stages; determining the research problems, searching for literature, reading and reviewing the contents of the literature, synthesizing the result of the literature and rewriting the results of the literature review into new ideas. The SciSpace website (<https://typeset.io/>) was employed to facilitate the discovery of the relevant literature align with the research theme.

RESULTS AND DISCUSSION

Perspective of Science Teachers of AI in Biology Education

The integration of AI in Biology education has an impact to pre-service and in-service science teachers. Mnguni et al (2023) found out that pre-service biology teachers view AI integration positively. In support, Kurniawan et al (2024) revealed pre-service biology teachers had a higher perception of AI in Biology

education than in-service teachers. Still, both groups believe that AI could enhance student achievement in Biology.

In-service science teachers show a positive perception of integrating AI in Biology education (Al Darayseh et al, 2023; Telaumbanua, 2025). Al Darayseh et al (2023) found out that science teachers in Biology education shows a high acceptability of AI use. This acceptability has a positively correlated with self-efficacy, ease of use, expected benefits and attitudes. Also, it enhances the understanding and motivation of the students (Telaumbanua, 2025). Furthermore, Paiva & Rodrigues (2024) mentioned that AI tools support lesson planning, enhance teaching effectiveness and address time constraints in professional development.

The content of the biology and AI tools can be integrated in the teaching and learning process. Park et al (2023) indicated that science teachers perceive AI and biology as complementary since it shares similarities in model and data usage. Son (2023) elaborated that science teachers' motivation for AI in Biology education is personal curiosity, enhancing student engagement and evaluating competencies. Also, teachers advocate AI tools to improve visualization, interdisciplinary lessons and effective information sourcing and fostering deeper understanding of biological concept.

Despite of the positive perspective of science teachers in integrating AI in biology education, there are concerns needed to be address. Kurniawan et al (2024) and Telaumbanua (2025) highlighted that there is a need for AI introduction in education for both pre-service and in-service for science teachers teaching biology. Align with this, Mnguni et al (2024) indicated that there is a need for tailored teacher training and equitable resource allocation to enhance AI adaptation in biology education. Also, Park et al (2023) mentioned the challenges in using AI in biology education, including content mastery confidence, curriculum adaptation and recommendation for comprehensive AI resources to support teachers.

Types of AI in Biology Education

There are various of Artificial tools can be utilized in the biology education. Every AI tool can be classified based on the use of it in the teaching and learning process in biology education.

Table 1. Types and Use of AI in Biology Education

No.	Types of AI Tools	Use	Author(s)
1	Personalized/ Adaptive Learning	Customizing content and pacing	Telaumbanua (2025); Aripin et al (2024); Yoo (2024)
2	Teaching Media & Visualization	Enhancing concept delivery	Telaumbanua (2025); Aripin et al (2024); Dasgupta & De (2023)
3	Virtual Laboratories	Simulating experiments	Telaumbanua (2025); Nguyen et al (2024); Yoo (2024)
4	Chatbots & Intelligence Agents	Assisting with queries and tutoring	Aripin et al (2024); Nguyen et al (2024); Yoo (2024)

5	Machine Learning Applications	Biological classification & data analysis	Baisova (2024); Huang et al (2024); Dasgupta & De (2023)
6	Lesson Planning Tools	Support teacher preparation	Aripin et al (2024); Baisova (2024); Paiva & Rodriguez (2024)

The table 1 shows six (6) types of AI tools commonly utilized in biology education. (a) The personalized/adaptive learning tools are used to adjust instruction based on students' performance, learning and styles and needs to improve individual learning outcomes. (b) The teaching media and visualization tools are the multimedia tools (VR, 3D models and visualization) to explain complex biology concepts, specifically anatomy, ecosystems and molecular biology. (c) The virtual laboratories tools are digital lab environment where students can perform biology experiments, such as, dissections, microscopy and chemical testing. (d) The chatbots and intelligent agents' tools are real-time support through natural language interaction to clarify biology lessons, reinforce learning and provide immediate feedback. (e) The machine learning application tools are AI algorithms such as, decision trees and SVM (Support Vector Machine) for species identification and promotes student understanding of biological data. (f) The lesson planning tools are AI platforms help teachers to generate text-based materials, design experiments and suggest activities aligned with biology topics and competencies of the curriculum.

Opportunities and Challenges of AI in Biology Education

AI integrated in biology education bring a transformative way of teaching and learning process. There are opportunities and challenges for science teachers in integrating AI in teaching Biology.

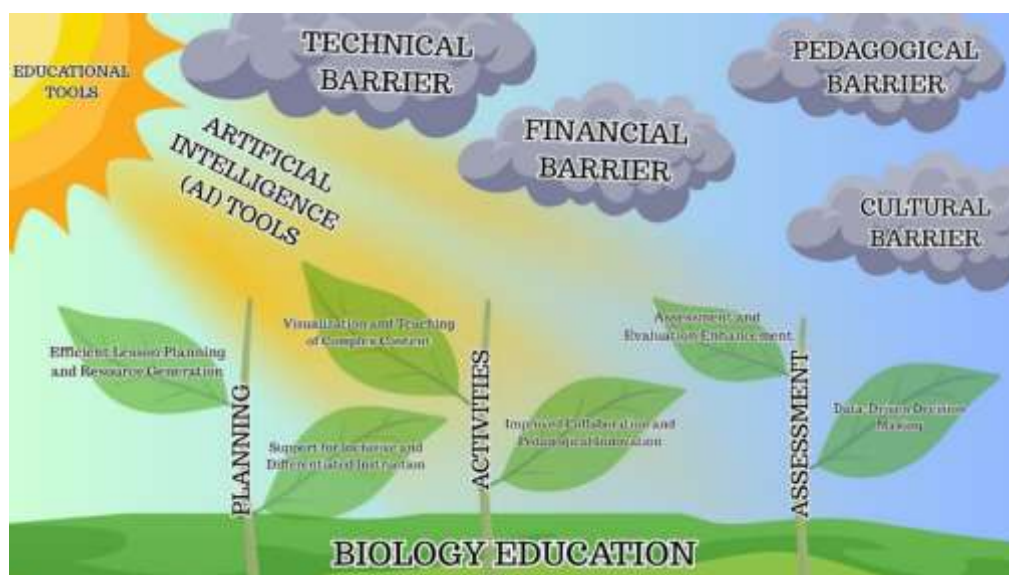


Figure 2. The Opportunities and Challenges in Integrating AI in Biology Education

The illustration 2 shows the opportunities and challenges of integrating AI in Biology education. The sun rays are the tools help Science teachers help to make the teaching and learning process in Biology meaningful, one of the tools is Artificial Intelligent. The leaves of the plant represent the opportunities of using AI in Biology education and the dark clouds that blocks some of the sun rays represents the challenges that hinder the integration of AI in Biology education.

AI in Biology education helps and guide science teachers to make plan, design activities and assess the achievement of the students. Paiva & Rodrigues (2024) and Nasution (2023) mentioned that AI can assist teachers in generating biology lesson plans, quizzes and learning materials. It reduces the planning time and helps to create engaging and diverse content in Biology. Further, Aripin et al (2024) elaborated that when teacher utilize AI, it can cater to diverse learners through adaptive tools that adjust content complexity and presentation which fosters equitable access to biology education.

In designing the learning activities of the students in Biology, Zahoor et al (2024) and Telaumbanua (2025) highlighted that AI tools offer visual aids and interactive modules that help teachers to explain intricate biological processes effectively. It increases teaching efficiency and improves student understanding. Also, Usak (2024) explained that AI fosters collaboration between traditional biology teachers and computational scientist that open new theoretical and instructional framework.

With developing the assessment in Biology, Nasution (2023) mentioned that AI tools can generate high-quality multiple-choice questions and assessments, enabling accurate and personalized evaluation of student progress. Also, it provides real-time feedback and data analytics to inform instruction. Moreover, Carr et al (2024) and Zahoor (2024) elaborated that AI facilitates analysis of student performance data to help teachers to make informed instructional decisions and monitor learning outcomes.

Despite the great opportunities that AI can bring to Biology education, there are multi-faceted barriers that science teachers face, such as, technical, financial, pedagogical and cultural.

There are many science teachers lack necessary knowledge and skills to integrate AI effectively into their teaching practices. With the rapid development of AI tools, it demands continuous professional development that most of science teachers have not received (Telaumabanua, 2025; Salloum et al, 2024). In connection with this, the existing syllabi or curriculum in biology are not designed to accommodate AI tools or methods. With this, science teachers need to redesign their lessons or assessments to align with AI-enhanced activities that correspond to the existing Biology curriculum (Saputra et al, 2023; Nehm, 2024).

There is a financial burden of adopting AI, especially in acquiring software licenses, hardware or teacher training programs. Since most of the schools will prioritize the pressing needs of the stakeholders (Kotsis, 2024; Das et al, 2024). Furthermore, most of the science teachers is lack of access to devices, stable internet or AI-enabled platforms which is a struggle to implement AI-based learning activities (Telaumabanua, 2025; Kotsis, 2024; Dechev, 2024). Align with this, the interdisciplinary in biology education is not always feasible or well-supported.

Science teachers may lack access to expert or collaborative structures that supports the integration of AI into biology education (Hassoun et al, 2021; Huang, Long & Lui, 2024).

AI tools are still prone to errors and fail to capture the nuances of biological languages and expressions. With this instance, it would be challenging and difficult for science teachers to trust and adopt AI grading tools and content generators due to inconsistencies and lack of transparency in results (Nhem, 2024; Buckchash et al, 2025). The concern about consent, data and ethical use of AI tools since these tools commonly collect and process personal data from students and teachers (Zahoor et al 2024; Tahir et al, 2024; Kotsis).

CONCLUSION AND RECOMMENDATION

The literature reviewed reveals that science teachers generally hold a positive perception of AI integration in Biology education. AI tools support adaptive learning, enhance visualization and improve lesson planning efficiency. Still, effective integration is hindered by challenges such as, lack of AI training, limited infrastructure, misalignment with curriculum and ethical concerns.

These are the following recommendations that can guide science teachers, curriculum planners and policy makers towards enhancing the use of AI in Biology education.

- Sustained professional development focused on AI integration in Biology should be provided.
- The curriculum, specifically the Biology content, should be aligned with AI tools and resources.
- Investment in infrastructure and equitable access to AI technologies in schools is essential.
- Clear policies should be established to address ethical issues and data privacy in the use of AI.

FURTHER STUDY

This research is limited to a review of existing literature and does not involve primary data collection. Future studies should explore empirical data from actual classroom implementations to validate the effectiveness and practicality of AI tools in biology education.

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