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Awareness, utilization, and pedagogical integration of Artificial Intelligence (AI) tools in biology teaching among science teachers: Toward the development of a training program

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Abstract

Artificial intelligence (AI) is increasingly used to support instructional planning, the development of learning materials, assessment, and student engagement. However, the extent to which science teachers are aware of, utilize, and pedagogically integrate AI tools in Biology teaching remains an important concern. This study determined the awareness, utilization, and pedagogical integration of AI tools among junior high school science teachers in the Division of Tagbilaran City, Bohol, and examined the predictive contribution of these variables to teachers' perceived teaching effectiveness and ability to promote student engagement. A quantitative approach using a descriptive-predictive research design was employed. The respondents were 32 junior high school science teachers teaching Biology in public secondary schools, selected through total enumeration. Data were gathered using an adapted structured questionnaire administered through Google Forms and analyzed using frequency, percentage, weighted mean, and multiple linear regression. ChatGPT was the most recognized, currently used, and most useful AI tool. Teachers were aware of AI tools (M = 3.81), frequently utilized them in Biology instruction (M = 3.74), and occasionally integrated them pedagogically (M = 3.35). Their perceived teaching effectiveness and ability to promote student engagement were rated positively (M = 3.68). The regression model significantly predicted the outcome (R^2 = .603, F = 14.17, p < .001); however, only awareness was a statistically significant predictor (B = 0.450, p < .001). Utilization and pedagogical integration were not significant predictors. The findings informed a proposed professional development program to strengthen teachers' AI literacy and support the effective, ethical, and curriculum-aligned integration of AI in Biology teaching.

Keywords: artificial intelligence, biology teaching, AI awareness, pedagogical integration, science teachers, teaching effectiveness

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1. Introduction

Artificial intelligence (AI) is increasingly influencing educational practice by providing tools that support lesson preparation, instructional resource development, assessment, feedback, and differentiated learning. These applications offer teachers additional ways to organize information, generate examples, and respond to learners' needs. Nevertheless, their educational value depends on how teachers select, evaluate, and incorporate them into instruction. A systematic review by Almasri (2024) identified diverse applications of AI in science education, including resource development, assessment, feedback, and prediction of academic performance. The review also highlighted challenges involving subject-specific accuracy, contextual appropriateness, and ethical use. Consequently, AI integration should be examined as an instructional and professional issue rather than simply as the adaption of new software.

Biology provides a relevant context for examining these developments. Students encounter interconnected systems, microscopic structures, and processes that cannot always be observed directly within classroom conditions. Understanding cellular processes, inheritance, ecological relationships, and biological change requires more than memorizing terminology. Teachers must help learners interpret representations, relate processes across organizational levels, and evaluate evidence. Reviews by Aripin et al. (2024) and Duran and Dikmenli (2025) identify applications of AI in Biology learning, including tutoring, assessment, teaching resources, and learning support. However, the available literature also indicates that research coverage is uneven across biological topics and types of AI-supported learning environments.

Generative AI applications have made some forms of AI assistance more accessible to teachers. Conversational systems can help draft lesson outlines, discussion questions, explanations, quizzes, and differentiated activities. Such outputs can provide starting points for instructional planning, but they should not be treated as scientifically authoritative or immediately suitable for classroom use. ElSayary (2024) found that teachers perceived benefits from ChatGPT particularly in lesson planning and teaching activities, while identifying information accuracy, bias, and reduced human interaction as important concerns. These findings position teachers as evaluators and instructional decision-makers rather than passive recipients of automatically generated materials.

Responsible integration also involves attention to privacy, inclusion, fairness, and human agency. Miao et al. (2021) emphasize that educational AI should strengthen human-centered pedagogy, empower teachers, and support equitable opportunities for learners. From this perspective, decisions about AI cannot be based only on convenience or the availability of particular applications. Teachers and schools must also consider what information is entered into systems, whether learners have equitable access, and whether AI use supports or displaces meaningful thinking. These considerations are particularly relevant when tools are introduced into activities involving minors or educational records.

1.1 Theoretical and conceptual foundations

The Technological Pedagogical Content Knowledge framework provides a foundation for examining the instructional use of AI. Mishra and Koehler (2006) explain that meaningful technology integration depends on the interaction of technological, pedagogical, and content knowledge. Knowledge of a tool alone is insufficient: teachers must understand how its capabilities relate to the subject matter and the teaching strategies needed to make that content understandable. In Biology, this means selecting technologies in relation to specific learning objectives, representations, misconceptions, and inquiry activities rather than adding digital features without a

clear instructional purpose.

Celik's (2023) Intelligent-TPACK framework extends this perspective to AI-supported instruction by incorporating AI-specific professional knowledge and ethical assessment. It recognizes that teachers need to understand how to interact with AI systems, identify their pedagogical contributions, and evaluate the fairness and appropriateness of their outputs or decisions. Importantly, technical knowledge becomes educationally meaningful when combined with pedagogical understanding. This perspective supports examining not only whether teachers know or use AI applications, but also how they incorporate those applications into subject-specific teaching and ethically responsible learning experiences.

The present study distinguishes awareness, utilization, and pedagogical integration. Awareness concerns teachers' reported familiarity with AI tools and their potential applications in Biology teaching. Utilization concerns the reported frequency of using AI for professional and instructional tasks. Pedagogical integration concerns the incorporation of AI into teaching approaches that address student empowerment, learner diversity, and motivation. Although related, these variables represent different aspects of practice. A teacher may frequently generate instructional materials without involving learners in evaluating AI outputs, developing independent judgment, or using AI to investigate scientific questions.

The outcome variable also requires careful interpretation. The questionnaire drew on the Teachers' Sense of Efficacy Scale, associated with teachers' beliefs about their capacity to support learning through instructional strategies, classroom management, and student engagement (Tschannen-Moran & Hoy, 2001). Accordingly, the present study examines teachers' perceived teaching effectiveness and ability to promote engagement. It does not directly measure instructional quality through observation, student engagement through learner reports, or achievement through assessments. This distinction establishes the appropriate boundaries for interpreting the findings.

1.2 Research rationale and objectives

Although AI tools are increasingly visible in education, teachers' understanding, confidence, and practices remain uneven. Traga Philippakos and Rocconi (2025) found that awareness of widely known applications did not necessarily correspond with strong conceptual understanding or confidence across instructional tasks. Their findings also identified professional development, clearer policies, and practical guidance as important support needs. Such evidence reinforces the value of investigating teachers' current practices within particular subjects and educational settings rather than assuming that general familiarity indicates readiness for meaningful integration.

The present study addresses this issue among junior high school science teachers assigned to teach Biology in the Division of Tagbilaran City, Bohol, Philippines. Its local focus is intended to inform professional learning priorities grounded in teachers' reported practices. Specifically, the study aimed to determine:

- The AI educational tools teachers recognized, currently used, and identified as useful.
- Their level of awareness of AI tools in Biology teaching.
- The extent of AI utilization in teacher management, instructional material development, and assessment.
- The extent of pedagogical integration in student empowerment, attention to diversity, and motivation.
- Their perceived teaching effectiveness and ability to promote student engagement.
- The predictive contribution of awareness, utilization, and pedagogical integration to the combined outcome.

The findings also served as the basis for a proposed professional development program for responsible and purposeful AI integration in Biology instruction.

2. Methodology

Research design - The study employed a quantitative approach using a descriptive-predictive research design. The descriptive component examined teachers' awareness, utilization, and pedagogical integration of AI tools, together with their perceived teaching effectiveness and ability to promote student engagement. It also identified the applications teachers recognized, used, and considered useful in preparing instruction. The predictive component examined whether awareness, utilization, and pedagogical integration contributed statistically to the explanation of variation in the outcome variable. Multiple linear regression enabled the contribution of each predictor to be examined while accounting for the other predictors included in the model. The analysis was observational and concerned associations among questionnaire scores. It was not designed to determine whether AI use caused changes in teaching effectiveness or student engagement.

Participants and research setting - The study was conducted in public secondary schools within the Division of Tagbilaran City, Bohol, Philippines. The respondents were 32 junior high school science teachers assigned to teach Biology. Total enumeration was the intended recruitment approach because all members of the identified population were invited to participate. The focus on teachers within one division provided a bounded setting for identifying locally relevant professional development needs. However, the findings should be interpreted in relation to this specific group and context. Participation by teachers from one division does not establish that the same patterns characterize science teachers elsewhere, particularly where access to technology, professional learning opportunities, or institutional expectations differ.

Research instrument - Data were collected using an adapted and modified structured questionnaire administered through Google Forms. The instrument consisted of five parts. The first identified AI tools respondents recognized, currently used, and considered useful. The second examined awareness of AI tools in Biology teaching. The third assessed utilization across teacher management, instructional material development, and student assessment. The fourth part addressed pedagogical integration through student empowerment, attention to diversity, and student motivation. The fifth assessed teachers' perceived teaching effectiveness and ability to promote student engagement through instructional strategies, classroom management, and student engagement items. This final component drew on the Teachers' Sense of Efficacy Scale developed by Tschannen-Moran and Hoy (2001). The distinction between the instrument's domains guided the analysis. Tool recognition was treated separately from awareness ratings, while utilization frequency was distinguished from pedagogical integration. Similarly, the outcome was interpreted as a self-reported perception of teaching capability rather than an independent evaluation of classroom performance.

Data collection and ethical considerations - Before collecting data, the researcher secured the required institutional and division approvals. Respondents were informed of the study's purpose, the voluntary nature of participation, the confidentiality of their responses, and their right to withdraw. The questionnaire link was distributed through the Division Science Supervisor to participating schools. Responses were retrieved electronically, checked for completeness, organized, and prepared for statistical analysis. Reporting emphasized aggregated results rather than individual responses. Because the study involved teachers' accounts of their professional practices, interpretation focused on identifying support needs rather than evaluating particular teachers or schools.

Data analysis - Frequency counts and percentages summarized the AI tools respondents recognized, currently used, and identified as useful. Weighted means summarized awareness, utilization, pedagogical integration, and the outcome variable. Descriptive interpretations followed the scoring categories used in the study. Multiple linear regression examined the predictive contribution of awareness, utilization, and pedagogical integration to teachers' perceived teaching effectiveness and ability to promote student engagement. Statistical significance was evaluated at the .05 level. Variance inflation factor and tolerance values were used to assess multicollinearity. The Shapiro–Wilk test was used to examine whether the residuals showed evidence of departure from normality.

3. Results and Discussion

3.1 AI tools recognized, used, and considered useful

ChatGPT was the most frequently identified tool across the three indicators. Of the 32 respondents, 96.9% recognized it, 93.8% reported current use, and 84.4% identified it as useful in preparing instruction. Canva AI ranked next, followed by Gemini. Recognition and use were therefore concentrated in a relatively small group of prominent applications.

Table 1
AI tools identified by respondents

AI tool	Aware of (%)	Currently used (%)	Identified as useful (%)
ChatGPT	96.9	93.8	84.4
Canva AI	84.4	75.0	56.3
Gemini	75.0	43.8	43.8
Grammarly	65.6	25.0	18.8
QuillBot	62.5	28.1	15.6
Scribbr	28.1	6.3	6.3
Quizizz AI	25.0	15.6	21.9
Khanmigo	18.8	6.3	9.4
Perplexity	18.8	12.5	6.3
Other tools	15.6	12.5	12.5
MagicSchool AI	12.5	12.5	9.4
Copy.ai	6.3	3.1	0.0
Diffit	3.1	0.0	0.0
Jasper	0.0	0.0	0.0
DreamBox	0.0	0.0	0.0

Note. Percentages are based on 32 respondents. The third column uses the neutral label "identified as useful" pending confirmation of the questionnaire's exact wording and response instructions.

The predominance of ChatGPT resembles the pattern reported by Traga Philippakos and Rocconi (2025), whose participants also most frequently recognized and used ChatGPT among the listed applications. However, similarity in tool preference should not be interpreted as equivalence in instructional practice. Teachers may use the same application for substantially different purposes, ranging from drafting administrative text to designing learning activities. The present findings establish the prominence of particular tools but do not identify the quality of individual outputs or the effectiveness of specific classroom uses. The difference between awareness and current use is also informative. For example, 75.0% recognized Gemini, whereas 43.8% reported using it. Similar gaps appeared for Grammarly and QuillBot. These differences indicate that recognition alone did not necessarily lead to adaption. The questionnaire results do not establish why respondents did not use particular tools. Possible explanations such as access, relevance, preference, or training needs require further investigation rather than being treated as findings.

3.2 Awareness, utilization, and pedagogical integration

Respondents obtained an overall awareness mean of 3.81, interpreted as Aware. The highest-rated item concerned imagining possible future uses of AI in Biology (M = 3.97), whereas knowing the most important AI concepts in Biology received the lowest mean (M = 3.66). This pattern suggests that teachers were receptive to potential applications while reporting comparatively less confidence in foundational concepts. The difference has implications for professional learning. Awareness of possibilities may provide a useful starting point, but it should not be equated with demonstrated AI literacy. The present study used self-reported awareness rather than a performance-based assessment of teachers' ability to explain AI processes, identify fabricated information, or evaluate ethical risks. Celik's (2023) framework supports a broader conception of professional knowledge that

connects technical understanding with pedagogical application and ethical assessment.

Overall utilization was 3.74, interpreted as Often. Creation of teaching materials had the highest dimension mean (M = 3.87), followed by teacher management (M = 3.76) and student assessment (M = 3.60). Generating examples and practical cases relevant to Biology classes was the most frequently reported practice (M = 3.97). These results indicate that AI use was particularly prominent in preparatory and resource-development tasks. This pattern is broadly consistent with ElSayary's (2024) finding that teachers perceived more benefits in planning and teaching activities than in assessment and feedback. Nevertheless, the lower assessment mean in the present study does not establish reluctance or inability. It indicates only that assessment-related uses were reported less frequently than other uses. Further inquiry would be needed to determine whether this reflected deliberate caution, limited opportunities, insufficient training, or other contextual factors.

Table 2
Summary of descriptive results

Variable or dimension	Mean	Interpretation
Awareness of AI tools	3.81	Aware
Utilization: Teacher management	3.76	Often
Utilization: Creation of teaching materials	3.87	Often
Utilization: Student assessment	3.60	Often
Overall utilization	3.74	Often
Pedagogical integration: Student empowerment	2.94	Sometimes
Pedagogical integration: Attention to diversity	3.58	Often
Pedagogical integration: Student motivation	3.54	Often
Overall pedagogical integration	3.35	Sometimes integrated
Perceived teaching effectiveness and student engagement	3.68	Agree

Note. Interpretations follow the scoring categories reported in the study.

Overall pedagogical integration was 3.35, interpreted as Sometimes Integrated. Attention to diversity (M = 3.58) and student motivation (M = 3.54) received higher ratings than student empowerment (M = 2.94). Teachers therefore reported more frequent use of AI to accommodate differences and support motivation than to promote learners' independent, critical, and responsible engagement with AI. The contrast between frequent utilization and occasional integration is a central descriptive finding. It suggests that AI had become part of teachers' work without being equally embedded in learner-centered processes. However, the difference between the two overall means was not tested statistically and should not be presented as a statistically significant gap. Its practical importance lies in the distinction between producing resources and designing opportunities for students to question, investigate, justify, and reflect.

3.3 Perceived teaching effectiveness and student engagement

The overall outcome mean was 3.68, interpreted as Agree. Classroom management received the highest dimension mean (M = 3.73), followed by student engagement (M = 3.71) and instructional strategies (M = 3.61). Respondents generally perceived themselves as capable of managing classrooms, applying instructional approaches, and encouraging participation. These findings describe teachers' beliefs about their professional capabilities. They do not demonstrate that AI improved classroom management or caused students to become more engaged. Moreover, the student engagement dimension reflects teachers' perceived ability to encourage engagement rather than direct evidence from learners. This interpretation is consistent with the teacher-efficacy origins of the outcome measure (Tschannen-Moran & Hoy, 2001). The positive outcome ratings are therefore best understood as contextual information about respondents' perceived teaching capability. To examine whether those perceptions correspond with classroom practice, future work could combine teacher questionnaires with observation, student feedback, and assessments of Biology understanding.

3.4 Predictive contribution of AI-related variables

The regression model significantly predicted teachers' perceived teaching effectiveness and ability to promote student engagement, $R = .777$, $R^2 = .603$, adjusted $R^2 = .560$, $F\ (3, 28) = 14.17$, $p < .001$. Together, awareness, utilization, and pedagogical integration accounted for 60.3% of the observed variance in the outcome within the analyzed dataset.

Table 3
Multiple linear regression predicting perceived teaching effectiveness and student engagement

Predictor	B	SE	t	*p*
Intercept	2.178	0.368	5.930	< .001
Awareness	0.450	0.078	5.800	< .001
Utilization	−0.235	0.118	−1.980	.057
Pedagogical integration	0.200	0.123	1.630	.115

Note. N = 32. $R = .777$; $R^2 = .603$; adjusted $R^2 = .560$; $F(3, 28) = 14.17$; $p < .001$. Coefficients and test statistics reproduce the supplied results.

Awareness was the only statistically significant individual predictor (B = 0.450, $p < .001$). Holding the other included predictors constant, a one-unit increase in the awareness score was associated with an estimated 0.450-unit increase in the outcome score. This is an association between reported scores, not evidence that increasing awareness through training would necessarily produce the corresponding improvement. Utilization had a negative coefficient (B = −0.235), but its association did not reach the .05 significance threshold ($p = .057$). It should not be interpreted as evidence that AI use reduces teaching effectiveness. Similarly, pedagogical integration had a positive but nonsignificant coefficient (B = 0.200, $p = .115$). The findings do not establish that integration is educationally unimportant; they indicate that its independent association was not statistically distinguishable from zero in this model. Reported diagnostic values did not suggest substantial multicollinearity: VIF values ranged from 1.14 to 2.24, and tolerance values ranged from .446 to .877. The Shapiro–Wilk test did not detect a departure from residual normality, W = .963, $p = .323$. These diagnostics support aspects of model interpretation but do not establish that all regression assumptions were satisfied.

3.5 Interpretation in relation to teacher knowledge

The awareness finding is compatible with frameworks emphasizing informed professional judgment. Mishra and Koehler (2006) position technological knowledge within its interaction with pedagogy and content, while Celik (2023) highlights the additional ethical demands associated with AI. From these perspectives, understanding a technology's capabilities and limitations can inform decisions about when, why, and how to use it. The present result is consistent with this reasoning, although it does not directly test the complete TPACK or Intelligent-TPACK framework. A further distinction is necessary between awareness as measured here and comprehensive AI competence. Teachers who rated themselves as more aware may also have felt more professionally confident in general. Because predictors and outcome were collected through the same self-report questionnaire, shared response tendencies may have contributed to their associations. The findings therefore support prioritizing deeper investigation of awareness and professional knowledge, rather than concluding that awareness is inherently more important than enacted pedagogical practice.

4. Educational Implications

Implications for teachers - The findings suggest that professional learning should connect AI familiarity with critical evaluation. Because awareness was associated with the outcome while foundational understanding remained a comparatively weaker area, teachers would benefit from opportunities to explain what tools can and cannot reliably do. Training should move beyond demonstrations of convenient features toward examining errors, unsupported claims, bias, and inappropriate assumptions. This direction is consistent with the professional knowledge and ethical assessment emphasized in Intelligent-TPACK (Celik, 2023). For Biology teachers, scientific verification should be incorporated into the resource-development process. A proposed workflow is to

identify the learning objective, generate or adapt material, check scientific claims against dependable subject resources, inspect representations and explanations, and revise the material for the intended learners. For example, a teacher developing a cellular respiration activity could evaluate whether an AI-generated explanation distinguishes processes accurately and whether its level of detail matches the curriculum. This is a recommended application, not an observed practice established by the study.

The occasional integration rating also suggests a need to plan from learning goals rather than tool availability. A teacher should first determine what students need to understand or demonstrate and then decide whether AI offers a suitable contribution. This principle follows TPACK's emphasis on the relationship among technology, pedagogy, and content (Mishra & Koehler, 2006). In some lessons, AI may support comparison or feedback; in others, direct observation, physical models, discussion, or laboratory work may be more appropriate. Assessment deserves particular attention because it was the least frequently reported utilization dimension. Teachers could practice reviewing AI-generated questions for scientific accuracy, ambiguity, curriculum alignment, and the reasoning demanded by answer options. AI-generated feedback should similarly be checked before being used to guide learners. Professional responsibility remains with the teacher, and the purpose of training should be to strengthen judgment rather than encourage the uncritical automation of assessment.

Implications for schools and educational leaders - For schools, the findings indicate that access and adaption should not be treated as sufficient evidence of successful integration. The prominence of ChatGPT and frequent utilization suggest that AI is already part of respondents' professional activities. Institutional support should therefore address the quality and conditions of use rather than focus exclusively on introducing additional applications. Miao et al. (2021) emphasize coordinated planning, teacher empowerment, ethical oversight, and evaluation as components of responsible educational AI implementation. Schools could develop practical guidance covering approved uses, protection of personal information, verification of instructional materials, transparency, and human responsibility for assessment decisions. Such guidance should distinguish teacher preparation from direct student use because these activities involve different supervision and access considerations. Teachers also need a clear process for raising questions about unfamiliar tools or uncertain uses rather than being expected to interpret broad ethical principles independently.

Sustained professional collaboration is another implication. Learning Action Cell sessions or other professional learning communities could be used to examine Biology lesson plans, compare original and AI-assisted materials, and discuss classroom evidence. A useful collaborative task would be to review an AI-supported lesson against shared criteria: scientific accuracy, curriculum relevance, cognitive demand, accessibility, student agency, and ethical safeguards. This would orient professional dialogue toward instructional quality rather than novelty. Equity should also shape implementation. Schools should avoid designing required activities around assumptions that all learners have personal devices, reliable connectivity, or paid subscriptions. Teacher-mediated demonstrations, shared resources, and equivalent non-AI tasks are possible planning options. These recommendations reflect the inclusive and human-centered approach advocated by Miao et al. (2021), not evidence that the participating schools currently experience particular access barriers.

Implications for learners - The comparatively low student empowerment mean identifies an important instructional priority. Learners should not be positioned only as recipients of resources produced more efficiently by teachers. Where developmentally appropriate and institutionally permitted, they could be taught to question AI-generated explanations, identify unsupported statements, and justify revisions using biological evidence. Such activities would connect responsible AI use with scientific reasoning rather than treating AI literacy as an isolated technical skill. For example, a teacher might provide a preselected AI-generated explanation of food-web relationships and ask students to identify claims, compare them with classroom resources, and revise inaccurate reasoning. The learning objective would be the quality of students' evaluation and explanation, not the sophistication of their prompting. This proposed approach aligns with the emphasis on learner agency and human-centered pedagogy in Miao et al. (2021).

Learners would also benefit from explicit expectations concerning transparency and academic integrity. Teachers could explain which forms of assistance are permitted, what students must complete independently, and how AI assistance should be acknowledged. Process records, oral explanations, and reflections on revisions could provide opportunities for students to demonstrate their own reasoning. Finally, differentiated resources should preserve meaningful intellectual challenge. Adapting vocabulary or providing additional scaffolding should not automatically reduce opportunities to analyze evidence or explain biological relationships. The purpose of AI-supported differentiation should be to improve access to worthwhile learning while maintaining student participation, teacher guidance, and opportunities for independent thought.

5. Proposed Professional Development Program

The study proposes a three-day face-to-face program entitled "AI-Enhanced Biology Teaching: Strengthening Science Teachers' AI Literacy, Utilization, and Pedagogical Integration." Its purpose is to strengthen responsible, curriculum-aligned, and learner-centered practice. The program is proposed from the findings; its effectiveness has not yet been evaluated.

5.1 Day 1: AI understanding and responsible judgment

The first day would address foundational concepts, capabilities, limitations, and ethical considerations. Participants would examine Biology-related outputs containing accurate, inaccurate, and insufficiently supported claims. Activities would require teachers to explain their judgments and document corrections. The main outputs would be an AI resource-evaluation checklist and a revised instructional explanation. Evaluation would focus on demonstrated verification and reasoning rather than confidence alone.

5.2 Day 2: Instructional design and assessment

The second day would focus on purposeful utilization. Teachers would begin with a Biology competency and develop lesson components, examples, differentiated resources, or assessment items. Prompt development would be taught as part of an iterative planning process involving clear objectives, contextual information, output inspection, and revision. Participants would submit an instructional package containing the original output, their modifications, and a rationale. Peer review would examine scientific accuracy, accessibility, alignment, and cognitive demand.

5.3 Day 3: Learner-centered integration and classroom application

The third day would address the relatively weak student empowerment dimension. Participants would design an activity requiring learners to evaluate information, investigate a question, explain evidence, or reflect on responsible AI assistance. Microteaching would provide opportunities to rehearse instructions, anticipate learner difficulties, and receive feedback. Each teacher would develop a classroom application plan specifying objectives, safeguards, access arrangements, and evidence to collect.

5.4 Follow-up and evaluation

The workshop should be followed by classroom implementation and professional review. Suggested evidence includes revised lesson plans, anonymized student work, teacher reflections, and peer observations, subject to appropriate permissions and safeguards. Evaluation should distinguish satisfaction, self-reported confidence, demonstrated professional knowledge, and classroom practice. Without follow-up evidence, the program should not be described as improving student outcomes. Its initial purpose is to build and assess teachers' capacity for more informed integration.

5.5 Limitations and Future Research

Several limitations qualify the findings. First, the study involved 32 teachers from one division. The local focus supports context-specific planning but limits generalization. The regression coefficients should be interpreted cautiously, particularly when drawing conclusions from nonsignificant results. Second, all principal variables were self-reported. Teachers' accounts may differ from observed practice, and collecting predictors and outcome through the same questionnaire creates the possibility of shared-method influences. The outcome does not directly establish student engagement, achievement, or teaching quality. Third, the observational design does not establish temporal ordering or causation. Greater awareness may contribute to confidence, but professionally confident teachers may also explore AI more actively. Other influences, including prior training, digital competence, institutional support, and access, were not included in the reported model. Fourth, the supplied methodological description does not establish the adapted instrument's complete validity and reliability evidence. Interpretation depends on the suitability of its items, response scales, and scoring procedures for the intended constructs and participants. Future studies could include additional divisions, performance-based AI literacy tasks, classroom observations, student reports, and Biology learning assessments. Longitudinal research could examine how knowledge and practice develop over time. Evaluations of the proposed program should investigate both professional learning and classroom implementation rather than relying solely on participant satisfaction.

6. Conclusion

Junior high school science teachers assigned to teach Biology in the Division of Tagbilaran City reported awareness of AI tools and frequent utilization, particularly for developing instructional materials. ChatGPT was the most widely recognized and commonly used application. However, pedagogical integration was occasional overall, and student empowerment received the lowest dimension rating. The regression model was statistically significant, with awareness emerging as the only significant individual predictor of teachers' perceived teaching effectiveness and ability to promote student engagement. These findings concern associations among self-reported scores and should not be interpreted as evidence that AI awareness or use caused improved instruction or student outcomes. The principal practical implication is to connect AI familiarity with scientific verification, ethical judgment, and learner-centered design. Teachers need opportunities to develop and demonstrate these capabilities; schools need supportive guidance and collaborative structures; and learners need opportunities to exercise independent reasoning. The proposed professional development program translates these priorities into a structured starting point for subsequent implementation and evaluation.

AI Use Disclosure - During preparation of this manuscript, the author used ChatGPT and Grammarly for language editing and idea generation. The author reviewed, verified, and revised the AI-assisted content and checked the cited sources. No confidential or personally identifiable information was entered into these tools. The author takes full responsibility for the final manuscript.

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