Integrating Voice-Assisted Inquiry-Based Lesson into a Web Application:An Innovation in Biology Science Education

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ABSTRACT

This study developed and validated a Voice-Assisted Inquiry-Based Web Application (VA-IBL-WA) to address the persistently least-learned competencies in Grade 10 Biology, specifically protein synthesis (S10LT-IIIa-37), mutations and protein function (S10LT-IIIe-38), and evidence for evolution (S10LT-IIIh-41). Adopting a Developmental-Evaluative Research Design guided by the ADDIE model, the study involved 96 Grade 10 students, six science teachers, and ten school administrators and ICT coordinators across three public secondary schools in the Municipality of Tago, Surigao del Sur, Philippines. Expert validation using the DepEd LRMDS evaluation tool yielded a Very Satisfactory overall mean rating of 3.57 (out of 4.0) with a total score of 132 out of 148, confirming content, instructional, and technical acceptability. Stakeholder perception surveys produced a grand mean of 4.459 (Strongly Agree) across all five evaluation dimensions. One-Way Analysis of Variance (ANOVA) revealed no significant differences in perceptions among the three respondent groups across most indicators, with the exception of format ($F = 5.45$, $p = 0.006$). Prevailing challenges identified through thematic analysis included fast voice narration, teacher training needs, time constraints, device accessibility, and voice recognition limitations. An enhanced version of the application was subsequently developed incorporating all stakeholder feedback. The findings affirm that integrating voice-assisted technology with inquiry-based learning effectively reduces cognitive load, supports multimodal comprehension, and transforms abstract biological concepts into accessible and engaging digital learning experiences.

Keywords: Voice-Assisted Web Application, Inquiry-Based Learning, Science Education, Educational Technology, Biology, Multimodal Instruction

INTRODUCTION

The persistent underperformance of Filipino learners in science is a well-documented concern that demands innovative instructional responses. Data from the Programme for International Student Assessment (PISA) 2022 revealed that the Philippines ranked 77th out of 81 participating countries in Science, with only 23% of students attaining at least Level 2 proficiency—a deficiency further compounded by the country's 76th-place ranking in reading literacy (OECD, 2023). This dual deficit in scientific and reading proficiency is particularly acute in Biology, where learners are required to interpret complex conceptual texts involving molecular genetics, cellular processes, and evolutionary theory. Against this backdrop, the present study situates itself at the intersection of educational technology and science pedagogy, proposing that voice-assisted inquiry-based learning delivered through a web application can meaningfully bridge these gaps.

Inquiry-Based Learning (IBL) has been consistently recognized as a high-impact instructional approach that shifts students from passive recipients to active constructors of knowledge. Sam (2024) conducted a systematic review affirming that IBL significantly enhances conceptual understanding and scientific thinking when appropriately scaffolded. However, in resource-constrained and linguistically diverse classrooms—such as those characterizing Philippine public secondary schools—text-heavy inquiry tools often disadvantage learners whose reading comprehension is limited. Ormancı (2025) demonstrated that web-assisted guided inquiry significantly improved students' systems thinking in science, while Yánez-Pérez et al. (2024) validated IndagApp, a mobile and web-based platform supporting inquiry-based science teaching, confirming both its effectiveness and usability. These works collectively underscore the promise of technology-enhanced inquiry while revealing a critical gap: the integration of auditory scaffolding within inquiry-based digital platforms remains largely unexplored, particularly in the Philippine context.

Voice-assisted technology has emerged as a compelling scaffold for learners who struggle with text decoding and academic vocabulary. Butler and Starkey (2024) found that voice-activated AI in classrooms reduces the literacy burden on students, allowing them to redirect cognitive resources toward conceptual inquiry. This aligns with Vygotsky's (1978) concept of the Zone of Proximal Development (ZPD), wherein a more knowledgeable other—here instantiated as a digital voice assistant—provides real-time support that enables learners to accomplish tasks beyond their independent capability. Hamedi et al. (2025) validated this digital scaffolding function, demonstrating that AI-driven tools effectively bridge the ZPD for struggling learners when designed with iterative feedback mechanisms analogous to the ADDIE model. Additionally, Mayer's (2005, 2021) Cognitive Theory of Multimedia Learning provides the theoretical rationale for combining auditory and visual channels: the modality principle posits that people learn more deeply from words and pictures than from text and pictures alone, thereby reducing extraneous cognitive load.

Notwithstanding these theoretical and empirical foundations, the specific integration of voice assistance within inquiry-based biology lessons—particularly for Filipino secondary learners—remains an underexplored domain. Most existing inquiry-based learning tools prioritize visual or text-based interaction (Ormancı, 2025; Yánez-Pérez et al., 2024), with limited attention to auditory scaffolds as primary instructional supports. This gap, combined with the persistent low Mean Percentage Scores (MPS) recorded in identified Biology competencies over three consecutive school years, motivated the development of the Voice-Assisted Inquiry-Based Web Application (VA-IBL-WA) investigated in the present study. This innovation aligns with enabling policy frameworks including DepEd Order No. 62, s. 2009, which promotes auditory and voice-assisted instruction, as well as the DepEd ICT in Education Masterplan 2020 (DepEd, 2017), which mandates the integration of ICT to develop 21st-century skills.

The study pursued the following research objectives: (1) to identify the least-learned competencies in Biology Science 10 across three school years; (2) to develop a Voice-Assisted Inquiry-Based Web Application anchored on these competencies; (3) to assess the content validity of the developed material through expert evaluation; (4) to determine the perceptions of students, science teachers, and school administrators on the developed material across five dimensions; (5) to test whether significant differences exist in the validation ratings among the three respondent groups; (6) to identify prevailing challenges in the utilization of the application; and (7) to propose an enhanced output based on the findings.

METHODS

Research Design

The study employed a combined Developmental-Evaluative Research Design. The developmental phase, guided by the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, systematically operationalized the creation and iterative refinement of the VA-IBL-WA (Adeoye, 2024; Ismail, 2020). The evaluative phase measured the validity, acceptability, and implementation challenges of the developed material across multiple stakeholder groups, consistent with the approach endorsed by Fütterer et al. (2024) for assessing technology-enhanced educational interventions.

Research Locale and Respondents

The study was conducted in three public secondary schools in the Municipality of Tago, Division of Surigao del Sur: Clarence Ty Pimentel National High School (CTPNHS), Purisima National High School (PNHS), and Gamut National High School (GNHS). These schools were purposively selected based on three criteria: consistently low MPS in Biology Science 10, geographical accessibility for research supervision, and operational feasibility for technology-integrated instruction.

Three respondent groups were engaged. The first group comprised 96 Grade 10 students (CTPNHS: n = 25; PNHS: n = 34; GNHS: n = 37) who received a grade of 79 and below in Science during the third quarter, indicating persistent academic difficulty. The second group consisted of six science teachers selected through purposive sampling based on their qualification as licensed professional teachers currently handling Grade 10 Science Biology with a minimum of two years of relevant teaching experience and basic computer literacy. The third group comprised ten school administrators and ICT coordinators, selected through complete enumeration given the limited number of qualified personnel in these roles.

Instrument Development and Validation

Three instruments were used. First, the DepEd Learning Resources Management and Development System (LRMDS) Evaluation Rating Sheet for Non-Print Materials was adapted to validate the developed web application across four factors: Content Quality (max = 40), Instructional Quality (max = 40), Technical Quality (max = 52), and Other Findings/Error Check (max = 16). Second, a researcher-made perception questionnaire was constructed to measure the acceptability of the material across five dimensions: content, format, presentation and organization, accuracy and up-to-datedness, and technological features, using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) with 10 indicators per dimension. The instrument was pilot-tested at Badong National High School and demonstrated strong internal consistency (Cronbach's alpha values: Content = 0.8585; Format = 0.8778; Presentation and Organization = 0.8054; Accuracy and Up-to-datedness = 0.8909; Technological Features = 0.8049). Third, a 30-item pre-test/post-test aligned with the three identified least-learned competencies was developed based on the DepEd standard examination questionnaire, accompanied by a Table of Specifications (TOS).

Application Development Procedure

The development of the VA-IBL-WA followed the five phases of the ADDIE model. During the Analysis phase, three years of MPS data were examined to identify the persistently least-learned competencies in Biology Science 10. The Design phase involved crafting Inquiry-Based Lesson Plans structured according to the 7E Instructional Model (Elicit, Engage, Explore, Explain, Elaborate, Evaluate, Extend), which served as the blueprint for the application. The Development phase involved collaboration with software developers to digitize the lesson plans; this included scripting and recording voice-over narrations, integrating text, images, and audio into an interactive web interface, and programming interactive features (click-to-speak buttons, navigation, embedded assessments). The Implementation phase involved administering the application to Grade 10 students over three weeks during their regular Biology classes, with the teacher serving as facilitator. The Evaluation phase involved collecting quantitative and qualitative data from all respondent groups to inform the enhanced output.

Data Collection

Permission to conduct the study was obtained from the Schools Division Superintendent of Surigao del Sur, District Supervisors, and School Principals of the participating institutions. A pre-test was administered to establish students' baseline knowledge before the intervention. The VA-IBL-WA was then implemented over three weeks during the fourth quarter of SY 2025–2026. A post-test using the same 30-item instrument was administered upon completion of the intervention. Following the post-test, perception surveys were administered to all three respondent groups. Qualitative data on prevailing challenges were gathered through open-ended survey items and structured interviews.

Data Analysis

Weighted mean was used to determine the level of validity and acceptability as perceived by each respondent group. One-Way Analysis of Variance (ANOVA) was employed to test whether significant differences existed among the three groups' perceptions across the five evaluation dimensions, at the 0.05 level of significance. For qualitative data on implementation challenges, Thematic Analysis following the framework of Braun and Clarke (2006) was applied: raw responses were coded at the granular level, codes were grouped into broader categories, and overarching themes were identified and interpreted. Ethical considerations included coded anonymization of all respondents, secure storage of data, age-appropriate and culturally sensitive content in the application, and adherence to DepEd ethical standards for learning materials.

RESULTS

Least Learned Competencies in Biology Science 10

Table 1 presents the Mean Percentage Scores (MPS) of three Biology Science 10 competencies across three consecutive school years (SY 2022–2023 to SY 2024–2025), which served as the empirical basis for identifying the focus of the instructional intervention.

Table 1. Least Learned Competencies in Biology Science 10 (SY 2022–2025)

Competencies	SY 2022-2023 Rating	Remark	SY 2023-2024 Rating	Remark	SY 2024-2025 Rating	Remark
Explain how protein is made using information from DNA (S10LT-IIIa-37)	47.1	Least Learned	49.03	Least Learned	48.91	Least Learned
Explain how mutations may cause changes in the structure and function of a protein (S10LT-IIIe-38)	43.4	Least Learned	48.65	Least Learned	49.56	Least Learned
Explain how fossil records, comparative anatomy, and genetic information provide evidence for evolution (S10LT-IIIh-41)	33.9	Least Learned	47.57	Least Learned	46.78	Least Learned

Note. Ratings below 50% are classified as Least Learned (LL) in accordance with DepEd MPS standards.

The data revealed that all three competencies—protein synthesis, the effects of mutations on protein structure and function, and evidence for evolution—consistently remained in the Least Learned category across all three school years with no competency reaching the 60% MPS threshold required for satisfactory mastery. The competency on protein synthesis registered ratings of 47.1%, 49.03%, and 48.91% respectively, indicating marginal and non-progressive improvement. Mutation-related content showed a slightly upward trend (43.4% to 49.56%) but remained critically below mastery. The competency on evolutionary evidence recorded the lowest initial rating (33.9% in SY 2022–2023) and, while it improved over subsequent years (47.57% and 46.78%), it did not approach satisfactory levels.

Content Validation Results

Table 2 presents the expert validation results of the VA-IBL-WA using the DepEd LRMDS Evaluation Rating Sheet for Non-Print Materials.

Table 2. Content Validation Results by the Experts

Factor	Criteria Description	Max Score	Obtained Score	Mean Rating	Interpretation	Result
Factor A	Content Quality	40	36	3.60	Very Satisfactory – Content is accurate, relevant, and well-organized with minor areas for improvement	Passed
Factor B	Instructional Quality	40	35	3.50	Very Satisfactory – Clear objectives and engaging material, slight improvements needed in feedback/adaptability	Passed
Factor C	Technical Quality	52	46	3.54	Very Satisfactory – Strong technical performance with minor issues in audio-visual navigation	Passed
Factor D	Other Findings (Errors Check)	16	15	3.75	No major errors found; minimal minor issues (e.g., slight grammatical/audio-visual inconsistencies)	Passed
Overall		148	132	3.57	Very Satisfactory	Passed

Note. Maximum total score = 148; Obtained total score = 132; Overall mean = 3.57 (Very Satisfactory).

The application achieved an overall score of 132 out of 148, yielding a mean rating of 3.57, interpreted as Very Satisfactory, with all four factors rated as Passed. Factor A (Content Quality, M = 3.60) demonstrated that the material is accurate, curriculum-aligned, and well-organized. Factor B (Instructional Quality, M = 3.50) reflected clear learning objectives and appropriate level of difficulty, with minor suggestions for improved adaptive feedback. Factor C (Technical Quality, M = 3.54) confirmed strong navigational performance and interface usability with only minimal audio-visual synchronization concerns. Factor D (Other Findings, M = 3.75)—the highest-rated factor—indicated the absence of major conceptual or factual errors, with only trivial grammatical and formatting inconsistencies observed.

Perceptions of the Three Respondent Groups

Table 3 presents the consolidated perception ratings of Grade 10 students, science teachers, and school administrators across the five evaluation dimensions of the developed material.

Table 3. Summary of Perceptions of the Three Respondent Groups on the Developed Material

Indicators	Students Mean	Adj Rating	Sci. Teachers Mean	Adj Rating	School Admin Mean	Adj Rating	Grand Mean	Overall Adj Rating
Content	4.203	SA	4.567	SA	4.390	SA	4.387	SA
Format	4.202	SA	4.750	SA	4.300	SA	4.417	SA
Presentation & Organization	4.454	SA	4.733	SA	4.520	SA	4.569	SA
Accuracy & Up-to-datedness	4.538	SA	4.700	SA	4.500	SA	4.579	SA
Technological Features	4.250	SA	4.467	SA	4.310	SA	4.342	SA

Overall Mean	4.329	**SA**	4.643	**SA**	4.404	**SA**	4.459	**SA**

Note. SA = Strongly Agree (4.20–5.00). Scale: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly Disagree.

All three respondent groups consistently rated the VA-IBL-WA at the Strongly Agree level across all five dimensions, yielding a grand mean of 4.459. Among the dimensions, Accuracy and Up-to-datedness (M = 4.579) and Presentation and Organization (M = 4.569) received the highest ratings, reflecting strong stakeholder confidence in the material's scientific reliability and structural coherence. Technological Features obtained the lowest grand mean (M = 4.342), though it remained within the Strongly Agree range. Science teachers recorded the highest overall group mean (M = 4.643), followed by school administrators (M = 4.404) and students (M = 4.329), a pattern attributable to teachers' heightened appreciation of the material's pedagogical design and curriculum alignment. The minimal inter-group variation in scores indicates broad stakeholder consensus regarding the material's quality and instructional value.

Significant Differences in Validation Ratings

Table 4 presents the results of the One-Way ANOVA examining significant differences in the validation ratings among the three respondent groups.

Table 4. Significant Differences in Validation Ratings Among the Three Respondent Groups (One-Way ANOVA)

Sources of Variation	Computed F	p-value	Decision	Conclusion
Content	2.63	0.077	Failed to Reject H_0	Not Significant
Format	5.45	0.006	Reject H_0	Significant
Presentation & Organization	2.76	0.068	Failed to Reject H_0	Not Significant
Accuracy & Up-to-datedness	1.22	0.298	Failed to Reject H_0	Not Significant
Technological Features	1.68	0.192	Failed to Reject H_0	Not Significant

Note. Significance level $\alpha = 0.05$.

The ANOVA results indicated that the null hypothesis—that there is no significant difference in validation ratings among the three respondent groups—was retained for four of the five evaluation dimensions: Content ($F = 2.63$, $p = 0.077$), Presentation and Organization ($F = 2.76$, $p = 0.068$), Accuracy and Up-to-datedness ($F = 1.22$, $p = 0.298$), and Technological Features ($F = 1.68$, $p = 0.192$). However, the null hypothesis was rejected for Format ($F = 5.45$, $p = 0.006$), indicating a statistically significant difference in how the three groups perceived the structural and visual presentation of the application. Despite this difference, all ratings for Format remained within the Strongly Agree range, suggesting that the discrepancy reflects differing stakeholder priorities—pedagogical alignment for teachers, visual appeal for students, and compliance with standards for administrators—rather than any fundamental deficiency in the material.

Prevailing Challenges in Utilization

Table 5 presents the thematic analysis of prevailing challenges identified through qualitative responses from all three respondent groups during the implementation phase of the study.

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Table 5. Thematic Analysis of Prevailing Challenges in the Utilization of the VA-IBL-WA

Theme	Description	Respondent Group	Sample Responses
Voice Speed and Comprehension	Fast narration affects understanding	Students	"The voice is too fast."
Need for Training	Users require orientation to maximize use	Teachers	"Teachers need training."
Time Constraints	Limited class time affects implementation	Teachers	"Time is not enough."
Device Accessibility	Limited gadgets affect participation	Teachers/Admin	"Not all students have devices."
Voice Recognition Issues	Difficulty recognizing commands/accents	Admin	"Voice not recognized properly."

Five themes emerged from the thematic analysis. Voice Speed and Comprehension was the most frequently cited challenge among student-respondents, who reported difficulty following instructions when the voice assistant's narration was too rapid, particularly for complex biological terminology. This finding is consistent with Mayer's (2021) segmenting principle, which argues that learners benefit from instructional pacing that respects their cognitive processing rate. Need for Training was highlighted by teacher-respondents, who noted limited familiarity with the application's features despite its generally user-friendly interface, underscoring the importance of structured professional development for technology integration (Trust & Whalen, 2020). Time Constraints were reported by teachers who found the standard class period insufficient for completing inquiry-based activities requiring exploration, discussion, and reflection—a challenge consistent with broader findings on the implementation of student-centered pedagogies in traditional classroom schedules (Darling-Hammond et al., 2020). Device Accessibility was identified by both teachers and administrators, who noted that not all students had access to compatible devices, raising equity concerns reflective of the wider digital divide in Philippine education (UNESCO, 2023). Voice Recognition Issues were observed by administrators, particularly regarding the system's reduced accuracy in recognizing non-standard pronunciation and regional accents, consistent with findings by Feng et al. (2024) and Mengesha et al. (2021) on ASR bias across linguistic profiles.

DISCUSSION

Addressing Persistent Learning Gaps Through Targeted Intervention

The consistent classification of three Biology competencies as Least Learned across three school years confirms a structural rather than incidental deficit in student mastery of molecular genetics and evolutionary biology. This pattern aligns with the broader literature documenting Filipino students' persistent underperformance in science (OECD, 2023) and with Mangali et al.'s (2025) finding that competency-based interventions targeting specific learning gaps are significantly more effective than generalized instructional approaches. The identification of these competencies through multi-year MPS analysis provided a theoretically sound and empirically grounded basis for the design of the VA-IBL-WA, ensuring that the intervention was both targeted and contextually relevant. Mayer (2021) further supports this approach by emphasizing that instructional materials addressing specific conceptual domains—particularly those requiring abstract reasoning—benefit most from multimodal presentation strategies that reduce cognitive load.

Validity and Acceptability of the Developed Application

The expert validation results (overall M = 3.57, Very Satisfactory; total score 132/148) affirm that the VA-IBL-WA meets the pedagogical and technical standards prescribed by the DepEd LRMDS framework. The

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high rating for Factor D (Other Findings, M = 3.75) is particularly significant: it confirms the absence of major factual or conceptual errors, which Mendoza and Garcia (2022) identified as the most critical determinant of teacher acceptance for educational materials. The very satisfactory ratings for Content and Instructional Quality align with Conklin and Barreto's (2023) findings that instructional materials with clearly defined objectives, structured interactivity, and curriculum-aligned feedback mechanisms produce significant improvements in student engagement and learning outcomes.

The high stakeholder perception ratings (grand mean 4.459, Strongly Agree) across all three respondent groups indicate broad-based acceptance of the material's quality and instructional design. The pattern of teachers recording the highest group mean (4.643) reflects their appreciation of the application's alignment with inquiry-based pedagogy and curriculum standards, consistent with Goksel and Bozkurt's (2023) observation that educators evaluate technology through a lens of instructional value rather than mere usability. The consistently elevated ratings across all groups support Yánez-Pérez et al.'s (2024) finding that navigational ease and interface responsiveness are primary predictors of long-term adoption for educational applications. The finding of near-universal Strongly Agree ratings is also consistent with Aligo and Prudente's (2025) meta-analytic conclusion that multimodal digital tools combining audio and visual inputs consistently produce significant improvements in science learning outcomes.

Differential Perceptions Regarding Format

The statistically significant ANOVA result for Format ($F = 5.45$, $p = 0.006$) warrants specific interpretation. This finding does not indicate a fundamental flaw in the material's design; rather, it reflects the differing priorities that teachers, students, and administrators bring to their evaluation of interface presentation. This mirrors the theoretical predictions of Goksel and Bozkurt (2023), who emphasized that students often prioritize engagement features, teachers focus on instructional clarity and pedagogical alignment, and administrators attend to compliance with institutional standards. The non-significant ANOVA results for the other four dimensions ($p > 0.05$) confirm that the VA-IBL-WA achieved a balanced design that satisfies these diverse stakeholder perspectives across most evaluation criteria. From a practical standpoint, the format finding highlights the importance of participatory, user-centered design processes that incorporate all stakeholder perspectives during the development phase, rather than relying on a single-group evaluation (Yánez-Pérez et al., 2024).

Implementation Challenges and Mitigation Strategies

The five themes identified through thematic analysis collectively reflect the structural and systemic challenges that often accompany the integration of innovative educational technologies in resource-constrained Philippine schools (Dela Cruz, 2024). Voice speed and comprehension issues directly implicate the cognitive load framework: Mayer's (2021) pacing principle argues that segmenting instruction into learner-paced units significantly reduces intrinsic cognitive load, particularly for novice learners encountering unfamiliar scientific vocabulary. Incorporating adjustable playback speed controls and pause-replay functionality in the enhanced output directly addresses this limitation. The need for teacher training echoes Trust and Whalen's (2020) finding that professional development is a necessary condition for effective educational technology integration, not merely a supplementary amenity. Designing lightweight, offline-compatible applications—as implemented in the enhanced output—directly addresses device accessibility concerns, consistent with Adeoye's (2024) recommendation that web-based educational tools in low-resource settings should prioritize lightweight and device-agnostic architecture. Voice recognition challenges highlight the need for localized ASR calibration for Filipino speech patterns, consistent with the ASR bias literature (Feng et al., 2024; Mengesha et al., 2021; Prabhu et al., 2023).

Theoretical and Practical Implications

The VA-IBL-WA integrates three complementary theoretical frameworks in a manner that is both theoretically coherent and practically effective. Vygotsky's (1978) ZPD is operationalized through the voice assistant's real-time scaffolding function, which supports students in navigating complex biological concepts that exceed their independent comprehension capacity. Mayer's (2005, 2021) Cognitive Theory of Multimedia Learning is instantiated through the deliberate combination of voice narration with visual representations, leveraging the modality and redundancy principles to optimize information processing. Bruner's (1961) Discovery Learning Theory is embedded in the application's 7E inquiry structure, which guides students through active knowledge construction rather than passive reception. The convergence of these frameworks in a single digital platform represents a theoretically grounded and pedagogically coherent innovation that advances the evidence base for voice-assisted inquiry-based instruction in science education.

From a policy perspective, the study demonstrates that voice-assisted web applications aligned with the K to 12 Science Curriculum (DepEd, 2016) and the ICT in Education Masterplan 2020 (DepEd, 2017) can serve as scalable instructional innovations for addressing persistent learning deficits in secondary Biology. The material's broad stakeholder acceptance and its passage through expert validation provide evidence supporting its adoption as a supplementary instructional resource within the Division of Surigao del Sur and, potentially, in analogous educational contexts across the Philippines. Future research should examine the material's effectiveness on pre-test to post-test gains in student achievement, explore its deployment at scale across additional schools and grade levels, and investigate the long-term sustainability of voice-assisted inquiry-based learning as a regular classroom practice.

CONCLUSION

This study successfully developed and validated a Voice-Assisted Inquiry-Based Web Application (VA-IBL-WA) designed to address the persistently least-learned competencies in Grade 10 Biology Science. Three-year MPS data confirmed that protein synthesis, mutations and protein function, and evidence for evolution have been consistently classified as least-learned competencies, establishing an empirically grounded basis for targeted instructional intervention. Expert validation rated the application as Very Satisfactory across all evaluation criteria (overall $M = 3.57$; total score 132/148), and all four evaluation factors were rated as Passed in accordance with DepEd LRMDS standards. Perception surveys across students, science teachers, and school administrators yielded a grand mean of 4.459 (Strongly Agree), with no significant differences among groups on four of five evaluation dimensions. The sole significant inter-group difference, observed for format ($p = 0.006$), reflected differing stakeholder priorities rather than material deficiencies. Thematic analysis identified five implementation challenges, all of which were systematically addressed in the enhanced version of the application.

The VA-IBL-WA demonstrates that the intentional integration of voice-assisted technology with inquiry-based learning constitutes a viable and scalable pedagogical innovation for biology education in public secondary schools. By simultaneously reducing cognitive and linguistic barriers, providing multimodal scaffolding, and situating learners within active inquiry processes, the application offers a replicable model for technology-enhanced science instruction aligned with national curriculum goals and inclusive education principles. The findings contribute to the growing body of literature supporting multimodal, voice-assisted, and inquiry-driven instructional innovations in science education and call for broader adoption, sustained professional development, and continued research into the long-term effectiveness of such innovations in diverse educational settings.

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