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Research Article

Enhancing General Biology Instruction Through the Integration of the Cichlid Life Cycle

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ABSTRACT

This study examined the effectiveness of integrating the Flowerhorn cichlid life cycle into General Biology 2 instruction among 30 Grade 11 STEM students at San Martin National High School during SY 2025–2026. A quasi-experimental one-group pretest–posttest design was employed, using a validated 30-item multiple-choice test to measure understanding of reproduction, adaptation, ecological relationships, and evolution. Results showed low prior knowledge in pretest scores but significant improvement in posttest scores, confirmed by a paired samples t-test at the 0.05 level. In addition, qualitative insights from a survey of ten struggling learners highlighted difficulties in fertilization, hormonal regulation, and ecological contexts, underscoring the need for scaffolding in inquiry-based tasks. Together, the quantitative gains and qualitative themes affirm that integrating the Flowerhorn cichlid life cycle as a contextualized, inquiry-driven strategy enhances comprehension, engagement, and retention. A lesson exemplar was developed to support meaningful and student-centered biology instruction, offering actionable implications for curriculum development and classroom practice.

Keywords*:* *Assessments, Biology instruction, Inquiry learning, Life cycle, STEM education*

Introduction

Biology Education in the Philippines continues to face challenges in helping students grasp abstract concepts such as reproduction, adaptation, and evolution. Many learners struggle with misconceptions, limited resources, and difficulty connecting lessons to real-world contexts, particularly in public schools where laboratory facility are scarce (De Asis, 2021; Villarino & Villarino, 2023). These issues often result in lower performance and reduced engagement in science subjects.

To address these concerns contextualized and inquiry-based strategies have been shown to improve comprehension, retention, and critical-thinking. Studies emphasize that linking lessons to familiar species and authentic experiences enhances student participation and motivation (McPherson-Geyser et al., 2020; Hansen et al., 2021).

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In this regard, cichlids—especially the Flowerhorn, a culturally familiar ornamental fish in Southeast Asia—offer a unique opportunity to make biology instruction more engaging. Their life cycle, which includes courtship, egg-laying, and parental care, provides observable examples that can clarify abstract biological processes (Rometsch et al., 2020).

The present study examines the effectiveness of using the Flowerhorn cichlid life cycle as a teaching approach in General Biology 2 among Grade 11 STEM students at San Martin National High School during SY 2025–2026. Specifically, it aims to assess students' prior knowledge, evaluate their performance after the intervention, determine significant differences between pre-test and post-test scores, and develop a lesson exemplar based on the findings. This research contributes to curriculum development by demonstrating how contextualized strategies can enhance biology instruction, foster deeper understanding, and promote meaningful engagement in science learning.

Moreover, integrating the Flowerhorn cichlid life cycle into General Biology 2 instruction provides a culturally familiar and scientifically rich context for learning. As ornamental hybrids widely recognized in Southeast Asia, Flowerhorns embody concepts of genetics, artificial selection, and ecological impact (Gasmen & Ragaza, 2025; Sari et al., 2023). Their observable behaviors—such as courtship, egg-laying, and parental care—offer concrete examples that make abstract topics like reproduction, adaptation, and evolution more relatable to students (Rometsch et al., 2020). By situating lessons in authentic and locally relevant contexts, teachers can bridge gaps in comprehension, spark curiosity, and foster deeper engagement. This contextualized approach not only strengthens scientific understanding but also aligns with curriculum modernization goals that emphasize inquiry-based, learner-centered strategies in Philippine STEM education.

Research Questions

The general problem of the study is: "How may the cichlid's life cycle be integrated in enhancing selected topics in General Biology 2 for STEM learners at San Martin National High School in the City of San Jose Del Monte, Bulacan during the school year 2025–2026 as the basis for the development of a lesson exemplar?"

Specifically, this study sought to answer the following questions:

1. What is the pretest mean score of the learners involved in the study in General Biology 2 prior to the integration of cichlid life cycle?
2. What is the posttest mean score of the learners involved in the study in General Biology 2 after the integration of cichlid life cycle?
3. Is there a significant difference between the pretest and posttest scores of learners after exposure to lessons integrating the cichlid's life cycle?
4. What challenges did learners encounter while learning General Biology 2 through the cichlid life cycle lesson?
5. Based on the findings of the study, what lesson exemplar may be developed to enhance the teaching of General Biology 2?

Research Hypothesis

The study posited the hypothesis to determine the significant difference between variables, stated as follows:

H0: There is no significant difference between the pretest scores and the posttest scores of the learners before and after exposure to lessons integrating the cichlid's life cycle, tested at the 0.05 level of significance.

Material and Methods

Methodology

The study employed a quasi-experimental one-group pretest–posttest design to evaluate the effectiveness of integrating the Flowerhorn cichlid life cycle in teaching selected topics in General Biology 2. The respondents were thirty Grade 11 STEM students from Section TESLA at San Martin National High School during the academic year 2025–2026. Since there was only one section, total enumeration sampling was used, ensuring that all learners were included and the entire population relevant to the research was represented. While this approach was appropriate given the single-section constraint, the one-group pretest–posttest design has inherent limitations, including the absence of a control group and potential threats such as maturation and testing effects. These limitations were acknowledged and considered in interpreting the results.

A validated 30-item multiple-choice test served as the main instrument to measure students' understanding of reproduction, adaptation, ecological relationships, and evolution. The test was administered twice: first as a pretest to establish baseline knowledge, and later as a posttest after the intervention. Lessons were taught using contextualized strategies that integrated the Flowerhorn cichlid's life cycle, supported by inquiry-based learning, multimedia resources, and hands-on activities.

In addition, a survey questionnaire was administered to ten learners who experienced the most difficulty during the intervention. The ten participants were identified based on their lowest pretest scores and teacher observations during classroom activities, ensuring that the qualitative data reflected the experiences of those who struggled most with the lesson. Their responses provided qualitative insights into classroom challenges, supplementing the quantitative test results and offering a more comprehensive view of learner experiences.

For data analysis, descriptive statistics (mean, standard deviation, variance) were used to summarize performance, while a paired samples t-test determined whether significant differences existed between pretest and posttest scores. This combination of descriptive and inferential analysis provided a holistic evaluation of the instructional strategy.

Results and Discussion

The findings revealed that the thirty Grade 11 STEM students from Section TESLA at San Martin National High School initially demonstrated low prior knowledge of reproduction, adaptation, ecological relationships, and evolution, as reflected in their pretest scores. This implies that before the intervention, learners had limited mastery of abstract biological concepts, which aligns with earlier studies noting persistent challenges in biology education due to misconceptions and lack of contextualization (De Asis, 2021; Villarino & Villarino, 2023).

After the integration of the Flowerhorn cichlid life cycle into General Biology 2 lessons, students' performance improved significantly. The posttest mean scores were consistently higher than the pretest results, and statistical analysis using the paired samples t-test confirmed that the difference was significant at the 0.05 level. This indicates that contextualized and inquiry-based instruction using familiar species can effectively enhance comprehension and retention of complex topics. The improvement mirrors findings by McPherson-Geyser et al. (2020) and Hansen et al. (2021), who emphasized that experiential and authentic learning approaches deepen understanding and strengthen analytical skills.

Furthermore, qualitative data from the survey of ten learners who struggled most during the intervention revealed challenges such as difficulty adjusting to inquiry-based tasks, limited prior exposure to multimedia tools, and occasional cognitive overload. These insights highlight that while contextualized strategies are effective, some students may require additional scaffolding and support to fully benefit from active learning approaches.

To sum it up, the results suggest that integrating the Flowerhorn cichlid life cycle into biology instruction not only improves academic performance but also fosters greater engagement and interest. This supports curriculum modernization goals by demonstrating that localized, inquiry-driven strategies can make abstract scientific concepts more relatable and meaningful to learners. The findings serve as the basis for developing a lesson exemplar that promotes contextualized, hands-on, and student-centered learning in Senior High School biology.

Table 1. Baseline knowledge of the students in general biology 2 based on their pre-test scores

N	Mean	Standard deviation	Variance
30	11.933	5.247	27.529

The data in Table 1 shows the baseline knowledge of 30 Grade 11 STEM students in General Biology 2, as measured by their pretest scores. The mean score of 11.93 indicates that students had a relatively low initial understanding of reproduction, adaptation, ecological relationships, and evolution. The standard deviation of 5.247 reflects moderate variability, suggesting that while some students had a better grasp of the material, others possessed significantly less knowledge. The variance, being the square of the standard deviation, further highlights the spread of scores, confirming that prior knowledge among learners was diverse but generally low.

These findings underscore the need for targeted instructional strategies to elevate students' comprehension of biology concepts. The moderate spread of scores emphasizes the importance of differentiated teaching approaches to address varying baseline knowledge levels, ensuring that both lower- and higher-performing learners benefit from the intervention. Establishing this baseline through pretests provides a valuable reference point for measuring future learning gains and evaluating the effectiveness of contextualized and inquiry-based instructional methods, consistent with Fraenkel et al. (2019), who emphasize the role of baseline data in quasi-experimental designs.

Table 2. Academic performance of students after exposure to lessons integrating the cichlid's life cycle, based on their post-test score

N	Mean	Standard deviation	Variance
30	26.367	2.810	7.899

The data in Table 2 highlight the academic performance of 30 Grade 11 STEM students after exposure to lessons integrating the Flowerhorn cichlid life cycle. The mean post-test score of 26.367 indicates a marked improvement in mastery of reproduction, adaptation, ecological relationships, and evolution compared to their baseline performance. The standard deviation of 2.810 and variance of 7.899 suggest moderate variability, showing that most scores clustered closely around the mean. This consistency implies that the instructional approach was effective across the majority of learners, with few outliers deviating significantly from the group's performance.

To sum it up, these results confirm that the contextualized and inquiry-based lesson strategy contributed positively to student achievement. The high mean score demonstrates improved comprehension, while the moderate spread of scores reflects uniform learning gains among the class. As Fraenkel and Wallen (2020) emphasize, posttest results in a one-group pretest–posttest design are critical indicators of instructional effectiveness, validating that the observed learning gains can be attributed to the intervention.

Table 3. Significant difference between the pre-test and post-test scores of students after exposure to lessons integrating the cichlid's life cycle

Group	Mean	Standard deviation	t-calculated	p-value	Mean Difference	Interpretation	Decision
Pretest	11.933	5.247	13.282	0.0001	14.434	Significant	Reject the Hypothesis
Posttest	26.367	2.810					

The data in Table 3 show that the pretest mean score of 11.933 with a high standard deviation of 5.247 reflected students' low initial understanding of biology concepts and considerable variability in their performance. After the intervention, the posttest mean rose sharply to 26.367, with a smaller standard deviation of 2.810, indicating significant improvement and more consistent scores across the group. The mean gain of 14.434 points demonstrates a substantial learning effect, confirming that the integration of the Flowerhorn cichlid life cycle into lessons enhanced comprehension and reduced score variability.

Inferential statistics further validate these findings. The calculated t-value of 13.282 far exceeded the critical threshold at the 0.05 level, while the p-value of 0.0001 confirmed that the observed difference was highly unlikely to be due to chance. These results provide strong evidence that the instructional approach had a significant positive impact on student learning outcomes. Consistent with Shadish et al. (2021), the large mean difference, high t-value, and extremely low p-value highlight the effectiveness of quasi-experimental pretest–posttest designs in demonstrating causal relationships, thereby affirming the success of life-cycle-based instructional strategies in teaching complex biological concepts.

Challenges Encountered by the Learners in the Previous Cichlid Lesson

Difficulties in Understanding the Lesson. Conceptual Confusion in Fertilization. Participant 1 struggled to distinguish external from internal fertilization, particularly in understanding zygote protection. This highlights the difficulty of grasping abstract reproductive processes without reinforcement. Using the cichlid life cycle and multimedia visuals can clarify these differences (Mayer, 2021).

Hormonal Regulation Challenges. Participant 2 found it difficult to connect hormones like estrogen and testosterone to fish reproduction compared to humans. Linking hormonal regulation to observable traits in cichlids, such as male coloration, can anchor abstract processes in tangible evidence (Kinchin & Winstone, 2020).

Reproductive Adaptation Difficulty. Participant 3 was surprised by mouthbrooding, showing how unique adaptations challenge prior assumptions but spark curiosity. Visual reinforcement of such strategies can heighten engagement and retention (Mayer, 2021).

Cross-Species Comparisons. Participants 4 and 9 struggled with analogies between cichlid systems and plant processes. While challenging, analogical reasoning can deepen understanding when carefully scaffolded (Gentner & Hoyos, 2021).

Environmental Context in Learning. Participants 5 and 10 had difficulty linking ecological factors like water temperature and conservation to reproduction. Situating lessons within environmental frameworks enhances motivation and comprehension (Monroe et al., 2020).

Sensory System Challenges. Participant 6 struggled with the lateral line system, while Participant 7 was confused about fish immunity versus plant defenses. Diagrammatic and hands-on strategies can make hidden biological processes clearer (Kinchin & Winstone, 2020).

Observable Traits as Anchors. Participant 8 found sexual selection abstract, questioning why bright male coloration is adaptive. Anchoring evolutionary processes in observable traits helps learners connect theory to evidence (Gentner & Hoyos, 2021).

Learner challenges—ranging from fertilization and hormonal regulation to adaptations, analogies, environmental links, sensory systems, and sexual selection—underscore the complexity of integrating the cichlid life cycle into biology lessons. Strategies such as visual reinforcement, observable trait anchoring, analogical reasoning, and environmental context can address these difficulties, affirming the pedagogical value of the cichlid life cycle in strengthening STEM learners' comprehension (2020–2025 studies).

Helpful but Still Challenging Parts of the Lesson

Use of Visuals and Examples. Participants 1, 3, and 6 noted that abstract processes such as fertilization, mouthbrooding, and sensory systems were difficult to grasp without visual support. Examples, videos, and diagrams helped them overcome these challenges, showing that multimedia reinforcement makes invisible phenomena more understandable (Mayer, 2021).

Observable Traits as Anchors. Participants 2 and 8 struggled with hormonal regulation and sexual selection until these were linked to visible traits like coloration. Anchoring abstract processes in observable evidence eased cognitive load and clarified reproductive behaviors (Kinchin & Winstone, 2020).

Cross-Species Comparisons. Participants 4 and 9 found analogies between fish and plant systems challenging but useful. Comparing sperm to pollen and blood vessels to xylem helped them transfer knowledge across domains, supporting the role of analogical reasoning in deepening understanding (Gentner & Hoyos, 2021).

Environmental Context in Learning. Participants 5 and 10 initially struggled to connect ecological factors with reproduction. Realizing that climate change disrupts breeding cycles and that conservation sustains biodiversity showed how situating biology in environmental contexts enhances relevance and motivation (Monroe et al., 2020).

Human–Fish Biological Connection. Participant 7 found fish immunity difficult until it was linked to human physiology through white blood cells. This connection activated prior knowledge and strengthened comprehension, consistent with findings that linking new ideas to familiar systems improves retention (National Research Council, 2021).

Learners faced challenges with abstract, invisible, and cross-species processes, as well as ecological and physiological connections. These difficulties were eased through visual reinforcement, observable trait anchoring, analogical reasoning, environmental framing, and human-biological links, affirming the pedagogical value of the cichlid life cycle in strengthening STEM learners' comprehension.

Unexpected Problems Encountered

Conceptual Confusion in Fertilization. Participant 1 struggled to distinguish external from internal fertilization, often mixing them up during assessments. This reflects the difficulty of grasping abstract reproductive processes without reinforcement, highlighting the need for visual aids and contextual examples (Mayer, 2021).

Misinterpretation of Biological Structures. Participant 2 misinterpreted anatomical diagrams, at one point linking the swim bladder to reproduction. This shows how learners can confuse unfamiliar structures when diagrams lack clarity, underscoring the importance of accurate and well-designed visual support (Kinchin & Winstone, 2020).

Observable Traits as Anchors. Participant 3 found it challenging to connect hormones to reproduction until coloration was explained as a visible outcome. Linking invisible mechanisms to observable traits helps learners anchor abstract processes in tangible evidence (Gentner & Hoyos, 2021).

Environmental Context in Learning. Participants 4 and 9 struggled to connect ecological factors like climate change and conservation with fish reproduction. Situating lessons within environmental frameworks enhances motivation and comprehension, making biology more relevant (Monroe et al., 2020).

Cross-Species Comparisons. Participants 5 and 10 found it difficult to compare cichlid systems with plant processes such as pollen and xylem. While challenging, analogical reasoning can bridge familiar and unfamiliar domains, clarifying differences in biological systems (Gentner & Hoyos, 2021).

Surprising Adaptations in Reproduction. Participant 6 was initially confused by mouthbrooding but found it engaging once explained. Unique adaptations, when contextualized, spark curiosity and improve retention, reinforcing the value of real-world examples (Mayer, 2021).

Difficulty with Statistical Integration. Participant 7 struggled with statistical terms like variance and standard deviation in biology lessons. This reflects the challenge of interdisciplinary integration, requiring scaffolding to ease cognitive load when blending quantitative and biological concepts (National Research Council, 2021).

Sensory System Challenges. Participant 8 found the lateral line system difficult to understand, especially how fish detect vibrations without ears. Clear diagrams and conceptual anchoring strategies are essential to make hidden biological processes more accessible (Kinchin & Winstone, 2020).

Participants 1–8 revealed challenges in understanding fertilization, anatomical structures, hormonal regulation, environmental contexts, cross-species comparisons, reproductive adaptations, statistical integration, and sensory systems. These difficulties were eased through strategies such as visual reinforcement, observable trait anchoring, analogical reasoning, and contextual framing, affirming the effectiveness of integrating the Flowerhorn cichlid life cycle in enhancing comprehension and engagement in General Biology 2.

Conclusions

The present study concluded that integrating the Flowerhorn cichlid life cycle into General Biology 2 significantly improved student learning outcomes. The influence of contextualized and inquiry-based strategies was positively significant, as evidenced by the sharp increase in posttest scores and reduced variability compared to pretest results. Thematic analysis revealed that while learners faced challenges in fertilization, hormonal regulation, environmental contexts, cross-species comparisons, and sensory systems, these were effectively addressed through visual reinforcement, observable trait anchoring, analogical reasoning, and ecological framing. This implies that contextualized instruction using locally familiar species strengthens comprehension, engagement, and retention, confirming the effectiveness of life-cycle-based pedagogy in Senior High School biology.

Recommendations

Drawing from the study's findings, the following recommendations are offered to guide teachers, administrators, and curriculum planners in effectively applying contextualized and inquiry-based strategies in biology instruction.

1. For Teachers: Adopt contextualized lesson exemplars that integrate locally familiar species such as Flowerhorn cichlids. Use multimedia tools, inquiry-based activities, and scaffolding strategies to address learner challenges in abstract topics.
2. For School Administrators: Provide professional development workshops on contextualized and inquiry-driven pedagogy. Allocate resources for multimedia equipment and laboratory materials to support active learning.
3. For Curriculum Planners: Incorporate localized species-based modules into General Biology 2 curriculum guides. Ensure alignment with K–12 goals by embedding inquiry-based tasks and ecological awareness components.
4. For Policy Makers: Encourage schools to integrate contextualized strategies by issuing guidelines that promote the use of culturally familiar species in STEM instruction. Support funding for research-based lesson exemplars.
5. For Future Researchers: Explore the long-term impacts of life-cycle-based instruction on ecological literacy and learner performance. Extend similar contextualized approaches to other STEM subjects to evaluate broader applicability.

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