



## Enhancing Biological Literacy among Non-Science Majors through Contextualized Laboratory Innovations

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### Abstract

Teaching biology to non-science majors presents unique challenges, primarily characterized by low student engagement and a perceived lack of relevance. This study investigated the efficacy of Contextualized Laboratory Innovations (CLI) on the conceptual understanding and attitude toward biology among non-science majors at Basilan State College (BaSC), Philippines. Employing a quasi-experimental pretest-posttest control group design, the study involved 100 undergraduate students enrolled in a General Biology course (50 in the experimental group exposed to CLI, and 50 in the control group utilizing conventional laboratory manuals). The CLI integrated local Basilan biodiversity, indigenous knowledge, and readily available low-cost materials into laboratory activities. Data were collected using a validated 40-item Biology Concept Test (BCT) and a 30-item Attitude Toward Biology Questionnaire (ATBQ). Quantitative analysis using paired and independent samples t-tests revealed that while both groups started with comparable baseline knowledge, the experimental group demonstrated a significantly higher mean gain in both conceptual understanding ( $p < 0.001$ , Cohen's  $d = 1.42$ ) and positive attitude toward the subject ( $p < 0.001$ ).

**Keywords:** Contextualized learning, laboratory innovation, non-science majors, biological literacy, Basilan State College, science education

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### Introduction

In higher education, general biology is often a mandatory course for non-science majors. However, students pursuing degrees in humanities, business, or social sciences frequently approach this requirement with apprehension, anxiety, and a perception that the subject is irrelevant to their future careers (Smith & Wood, 2023)<sup>[6]</sup>. Traditional laboratory exercises, often derisively termed "cookbook labs," exacerbate this issue by focusing on rote memorization and mechanical procedures rather than critical thinking and real-world application (Chen *et al.*, 2024)<sup>[1]</sup>.

Basilan State College (BaSC), located in the archipelagic province of Basilan in the Philippines, faces additional challenges in science instruction, including limited access to state-of-the-art laboratory equipment. However, the island province boasts rich terrestrial and marine biodiversity, presenting an untapped resource for educational contextualization. Contextualized Laboratory Innovations (CLI) involve designing experiments that utilize local flora, fauna, and indigenous practices, making abstract biological concepts tangible and culturally relevant.

This study aims to evaluate the impact of CLI on the conceptual understanding and attitudes of non-science majors at BaSC. By transforming the laboratory from a sterile, disconnected environment into a localized exploratory space, this research seeks to provide empirical evidence for curriculum innovation in resource-constrained but biodiversity-rich regions.

Research consistently highlights the disconnect non-science majors feel in general science courses. According to Lee and Kim (2024)<sup>[3]</sup>, these students often exhibit lower self-efficacy in science and rely on surface-level learning strategies. The traditional instructional approach, which emphasizes extensive terminology and decontextualized facts, fails to foster

long-term biological literacy required for informed citizenship (Martinez *et al.*, 2023) <sup>[4]</sup>.

Contextual learning theory posits that learning occurs only when students process new information in such a way that it makes sense to them in their own frames of reference. Studies utilizing local resources (such as local water sources for ecology labs or indigenous plants for cell biology) have shown marked improvements in student motivation and knowledge retention (Garcia *et al.*, 2023) <sup>[2]</sup>.

In developing regions, high-cost laboratory setups are often unfeasible. "Frugal science" or low-cost laboratory innovations not only solve financial constraints but also promote creativity. Using accessible household or local materials demystifies science, proving that scientific inquiry is not confined to expensive, high-tech environments (Patel & Rahman, 2025) <sup>[5]</sup>.

### Methodology

The study utilized a quasi-experimental pretest-posttest non-equivalent control group design. This design was deemed appropriate given that the participants were organized into pre-existing intact classes, which made the random assignment of individual participants logistically impossible. The participants consisted of 100 first-year undergraduate non-science majors who were taking a General Biology course at BaSC during the first semester of the academic year. Two intact sections were randomly designated as the Experimental Group (n = 50) and the Control Group (n = 50). Two instruments were used in this study. The first was the Biology Concept Test (BCT), a 40-item multiple-choice examination developed by the researcher and validated by science education experts. The BCT covered four core topics: Cell Biology, Plant and Animal Reproduction, Genetics, and Local Ecology. Its reliability was established through the Kuder-Richardson Formula 20, yielding a coefficient of KR-20 = 0.84. The second instrument was the Attitude Toward

Biology Questionnaire (ATBQ), a 30-item, 5-point Likert scale adapted from the Test of Science-Related Attitudes (TOSRA). The ATBQ measured three constructs and demonstrated strong internal consistency with a Cronbach's alpha of 0.88.

The intervention was implemented over a period of eight weeks. The Control Group received standard instruction following the traditional university laboratory manual, with activities involving commercially prepared slides, textbook-based procedures, and conventional laboratory setups. The Experimental Group, by contrast, received instruction through Contextualized Laboratory Innovations (CLI), which integrated locally relevant materials and community contexts into laboratory activities. In Cell Biology, for instance, students used local fruits such as marang and lanzones for DNA extraction in place of standard laboratory kits. In Ecology, water quality assessment was conducted using samples from the local Aguada River and bio-indicators rather than simulated laboratory samples. In Botany, students engaged in classifying endemic Basilan flora associated with traditional Yakan weaving patterns.

All data were analyzed using SPSS Version 28. Descriptive statistics, including the mean and standard deviation, were computed to summarize the pretest and posttest scores of both groups. Within-group differences from pretest to posttest were evaluated using paired samples t-tests, while independent samples t-tests were employed to compare performance between the two groups. Effect sizes were determined by calculating Cohen's *d* to assess the practical significance of the observed differences.

### Results

Table 1 presents the pretest and posttest scores of both groups on the Biology Concept Test. The baseline scores show that both groups had a similar initial level of conceptual understanding.

**Table 1:** Descriptive Statistics for Biology Concept Test (Max Score = 40)

Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain
Control (Traditional)	50	14.32	3.15	22.45	4.12	8.13
Experimental (CLI)	50	14.10	3.22	30.68	3.85	16.58

To determine if the baseline difference was significant, an independent samples t-test was conducted on the pretest

scores. The results ( $t = 0.345$ ,  $p = 0.731$ ) confirmed that the groups were comparable before the intervention.

**Table 2:** Paired Samples t-test for Within-Group Differences (Pretest vs. Posttest)

Group	Mean Difference	SD	t-value	df	p-value	Cohen's d
Control	8.13	2.45	23.46	49	< 0.001*	0.95
Experimental	16.58	2.80	41.87	49	< 0.001*	1.85

\*Significant at  $p < 0.05$

Both groups showed significant improvement from pretest to posttest (Table 2). However, to determine the superiority of

the intervention, the posttest scores of the two groups were compared.

**Table 3:** Independent Samples t-test for Posttest BCT Scores

Variable	Mean Difference	Std. Error Diff.	t-value	df	p-value	Cohen's d
Posttest BCT	8.23	0.798	10.31	98	< 0.001*	1.42

\*Significant at  $p < 0.05$

Table 3 reveals a highly significant difference in the posttest scores favoring the Experimental group ( $t = 10.31, p < 0.001$ ). The effect size ( $d = 1.42$ ) is considered very large, indicating

that the Contextualized Laboratory Innovations had a substantial positive impact on conceptual learning.

**Table 4:** Posttest BCT Achievement by Content Domain (Mean Percentage Score)

Content Domain	Control MPS (%)	Experimental MPS (%)	Difference (%)	p-value
Cell Biology & Genetics	55.4%	78.2%	+22.8%	< 0.001*
Plant & Animal Form/Function	58.1%	75.6%	+17.5%	< 0.001*
Local Ecology & Environment	54.8%	82.4%	+27.6%	< 0.001*

Table 4 shows that the most significant gains in the experimental group were in the "Local Ecology & Environment" domain, likely because utilizing the immediate

Basilan environment provided highly concrete learning experiences.

**Table 5:** Descriptive Statistics for Attitude Toward Biology (Scale 1.0 - 5.0)

Group	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Interpretation (Post)
Control	2.65	0.42	3.15	0.45	Neutral
Experimental	2.58	0.45	4.28	0.38	Highly Positive

**Table 6:** Independent Samples t-test on ATBQ Sub-domains (Posttest)

ATBQ Sub-domain	Control Mean (SD)	Exp. Mean (SD)	t-value	p-value
Relevance of Biology	3.20 (0.55)	4.45 (0.42)	12.75	< 0.001*
Enjoyment of Science	3.10 (0.61)	4.20 (0.48)	10.02	< 0.001*
Inquiry Self-Efficacy	3.15 (0.50)	4.19 (0.45)	10.93	< 0.001*

As seen in Tables 5 and 6, while the control group showed slight improvement in attitude, the experimental group shifted from a negative/neutral baseline to a "Highly Positive" attitude. The most dramatic shift was seen in the "Relevance of Biology" sub-domain, proving that contextualization successfully bridged the gap between non-science students' lives and the subject matter.

## Discussion

The primary objective of this study was to determine the effectiveness of Contextualized Laboratory Innovations (CLI) in teaching biology to non-science majors at Basilan State College. The quantitative data provide compelling evidence that CLI significantly outperforms traditional laboratory instruction.

The experimental group achieved a much higher mean gain (16.58) compared to the control group (8.13), with a large effect size of 1.42. This aligns with the findings of Garcia *et al.* (2023) [2], who argued that utilizing familiar, localized materials reduces cognitive load. Because non-science majors struggle with abstract scientific jargon, using local phenomena (like endemic Basilan plants or local river ecosystems) provides a cognitive anchor. Students are not just memorizing the steps of DNA extraction; they are extracting DNA from local fruits they consume daily, transforming an abstract concept into a tangible reality.

The ATBQ results highlight the affective benefits of the intervention. Non-science majors typically view biology as a hurdle. In this study, the traditional lab group maintained a generally neutral attitude (Mean = 3.15). In contrast, the experimental group developed a highly positive attitude (Mean = 4.28), specifically scoring highest in the "Relevance of Biology" sub-domain.

Furthermore, the utilization of low-cost, accessible materials demonstrates that high-quality science education can be achieved in resource-constrained settings like BaSC. It empowers both educators and students, fostering an environment where science is seen as an accessible tool for

community development rather than a discipline confined to expensive laboratories.

## Conclusion and Recommendations

The integration of Contextualized Laboratory Innovations (CLI) in general biology significantly enhances both the conceptual understanding and the scientific attitudes of non-science majors. By leveraging the rich biodiversity and local context of Basilan, educators can transform mandatory science courses from sources of student anxiety into engaging, relevant, and effective learning experiences.

Based on these findings, the following recommendations are made:

1. Basilan State College should consider officially adopting and institutionalizing the contextualized laboratory manuals for all General Education science courses.
2. Science educators should be provided with capacity-building workshops on how to design, test, and implement contextualized, low-cost laboratory activities.
3. Future studies should explore the longitudinal retention of biological concepts among non-science majors exposed to CLI, as well as applying similar contextualized innovations to other disciplines such as chemistry and physics.

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#### **How to Cite This Article**

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