Place-Based Inquiry Teaching Approach (PBITA): Effects on Junior High School Students' Conceptual Understanding in Biology

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ABSTRACT

This study examined the effects of the Place-based Inquiry Teaching Approach on Grade 8 students' conceptual understanding in Biology. Using a quasi-experimental design, two (2) sections of students from MSU-Tamparan Community High School during the school year 2024–2025 school year participated. Data were collected through a researcher-made Biology Conceptual Understanding Test (BCUT) with a reliability coefficient of 0.82. Analysis included descriptive statistics, independent samples t-test, and Levene's test at a 0.05 significance level. Specifically, the study investigated: (1) students' conceptual understanding levels in both experimental and control groups before and after the intervention; (2) significant difference between the mean scores of the experimental and the control group in their conceptual understanding test before and after the intervention and their mean gain score; and (3) the experimental group's perceptions of the Place-based Inquiry Teaching Approach. Findings revealed that after the intervention, 93.3% of students in the experimental group reached the "Developed" level of conceptual understanding compared to 46.7% in the control group. The experimental group had a significantly higher mean BCUT score (39.20) than the control group (28.27), with mean gains of 18.00 and 7.87, respectively ($p = 0.000$). Thematic analysis of student reflections and interviews revealed positive perceptions of the teaching approach, emphasizing its engaging and meaningful nature through real-life applications, local context exploration, and collaborative learning.

Keywords: *Place-based Inquiry Teaching Approach, Conceptual understanding, Biology education*

INTRODUCTION

The Place-based inquiry teaching approach is an innovative teaching approach that connects educational experiences to the students' local environment, culture, and community while it fosters active learning and critical thinking. This approach is a blend of inquiry and place-based education which encourages students to do the educational activities and

explorations outside the classroom through the process of inquiry learning. The idea of this approach is grounded that learning should extend beyond classroom walls and give importance on using local resources and socio-cultural context as an essential component of the learning process.

The approach of place-based inquiry in teaching and learning maximized the students' involvement in constructing knowledge with practical experiences in the real world. Students take an active role as researchers, problem solvers, critical thinkers and exploring real world issues within the local community. Students in this setting are engage in their community, work collaboratively with their peers and community members to investigate problems in society through inquiry skills, to prepare their understanding about the environment and to work on solution of the existing problems. Meanwhile, the teachers serve as facilitators and designers of learning experiences that encourage exploration and critical thinking rather than simply delivering the content. Teachers assist students to connect what they learn to local context and guide them to make a meaningful discovery (Khezang, 2020).

Moreover this approach enriches scientific learning by making it more engaging and connected to students' local surroundings. It integrates their out-of-school experiences with classroom knowledge which allowing them to explore topics through hands-on activities and participate in authentic science activities (Soares, 2022).

In the modern education it often neglected to embrace the importance of place where the study situated which results in abstract learning (Langran & DeWitt, 2020). Researches have shown that despite the Philippine government's initiatives to localize the science curriculum still it faces a persistent challenge. Many learners find it difficult to grasp complex biological concepts due to lack of contextual relevance and limited opportunities for practical and real-world application (Montero and Geducos, 2023). Additionally, students encountering a wide range of biological concepts have a difficulty to conceptualize since most of these processes are not visible to the naked eye. A common problem understands of abstract biological process such as cellular respiration and human body activities. The process involve molecular interactions that are difficult to visualize which often falls students to depend more on rote memorization instead of developing a deeper understanding (Aidoo et al., 2022).

Many students find it challenging to connect biological concepts to real life situations which make the subject irrelevant to them. It indicates that when a student view Biology as unrelated to their daily experiences their interest with lessons tends to decrease.

In the Philippines setting, science education is facing a dilemma as shown in the low achievement scores of students in the recent results released by the Programme for International Students Assessment (PISA)

2023, it showed that Filipino students continuously exhibit low proficiency in math, science, and reading. According to the data, the Philippines ranked 79th out of 81 participating countries in science. The average science score for Filipino students was 356, which is significantly below the OECD average of 485 (Chi, 2023).

Likewise, in the Trends International Mathematics and Science Study (TIMMS) that the Philippines scored 297 in Mathematics and 249 in Science in the year 2019 which is the lowest among 58 participating countries. The findings open the door to identify range of contributing factors that can help mitigate the students' alarming performance (Magas, 2023). Thus, this poor academic result calls for the persistent search of an effective teaching methods and learning science specifically in biology which culminated to discovery and suggestion by some researchers for the use of various innovative approaches, methods, and strategies that focus on active learning.

Saro et al., (2023) suggested that engaging in more meaningful learning activities can improve student's knowledge acquisitions. They demonstrated that localized and contextualized learning experiences play a significant role in improving the conceptual understanding of the students. Likewise, Swain (2023) proposed highlights that place-based pedagogies provide a versatile and adaptable method of instruction capable of supporting a variety of teaching strategies in post-secondary science education. This approach is especially advantageous in rural and remote areas, where technological resources and internet access are often limited.

Despite the continuous efforts to improve biology education, significant challenges remain in students' conceptual understanding in the subject. Hence, the researcher aimed to explore the use and benefits of the place-based inquiry approach as a potential solution to address the gap. The purpose of this study is to investigate the effects of Place-based inquiry teaching approach to the grade 8 students of MSU – Tamparan Community High school in terms of their conceptual understanding and interest in Biology lessons. The result will guide teachers involved in the Place-based inquiry process to present the lessons in a more meaningful and relevant local-based setting. Furthermore, the perception of the experimental group on the use of Place-based inquiry teaching approach was taken in support of the quantitative findings of the study.

METHOD

The study involved two Grade 8 sections (Rizal and Bonifacio) from Mindanao State University – Tamparan Community High School during the school year 2024–2025, with a total of 59 students. From these, 15 matched student pairs were selected based on their first-quarter Science grades for experimental comparison. The experimental group received instruction using the Place-Based Inquiry Teaching Approach (PBITA),

while the control group was taught using a Conventional Teaching Approach. Group designation was randomly assigned via coin toss.

In gathering the data of this study, the following were utilized: Conceptual Understanding Test (CUT) in Biology, reflective journal notes, one-on-one interview, and researcher's field notes. The CUT consisted of 91 validated multiple-choice items and open-ended questions scored using a rubric adapted from Brookhart (2013), with a reliability coefficient of 0.817.

The study followed three phases: pre-intervention, intervention, and post-intervention. During the pre-intervention phase, instruments were developed, validated by experts, and pilot-tested. The intervention phase lasted seven weeks, during which the experimental group followed the PBITA model, integrating local contexts and real-world investigations into the lessons, while the control group followed traditional instruction. Sample lessons, such as one on the digestive system, illustrated the PBITA's inquiry process involving observation, questioning, hypothesizing, data collection, and conclusion. After the intervention, a post-test on Conceptual understanding was administered to both groups. The completed tests were then collected, coded, and recorded. Scoring of the test followed and the result were statistically analyzed using descriptive statistics and t – test. Next, a schedule was then set for one-on-one interviews with students from experimental and control groups. The interviews were recorded using audio recorder. These recordings were transcribed to ensure accuracy and to validate the data gathered. In addition, the reflective journal notebooks of the subject participants of the experimental group were collected and analyzed. All of the qualitative data including interview transcripts and journal entries underwent thematic analysis to identify recurring patterns, insights and perceptions

The researcher prioritized ethical data collection and participant privacy by implementing several measures prior to gathering any information. Procedures put in a place to anonymize all collected data, including removing names, by assigning anonymous codes to participants during data collection.

Secure methods were established for collecting student grades and test scores. When obtaining data from students' reflective journal, protocols were prioritized anonymity and the comfort of participants. This includes anonymizing journal entries and one-on-one interview that do not disclose personal details. These measures ensured adherence to ethical guidelines and respect for participant privacy.

FINDINGS AND DISCUSSION

To determine whether the variances of the control and experimental groups were comparable in terms of their conceptual understanding of the topic domains in biology before and after intervention, variance is needed before a t-test because it helps calculate

the test statistic and ensures the assumptions for comparing group means are met (Bobbit, 2022). T-test independent sample was utilized to find out if there was a significant difference between the control and experimental groups of students' conceptual understanding test mean scores before and after intervention as well as their mean score. Table 1 shows the result of the statistical tests.

Table 1:
Levene's Test, t-test, and Significant (p) Values on the comparison of Control and Experimental Groups of Students' Conceptual Understanding Mean Score in biology before and after the intervention and the main gain score

Period	Group (n=15)	Levene's Test for equality of variances	Mean Score	SD	t-value	p-value
Pre-Intervention	Control	.14 .71	20.40	4.15	-.48	.63 (ns)
	Experimental		21.20	4.90		
Post-Intervention	Control	.56 .46	28.27	5.89	-4.85	.00 (s)
	Experimental		39.20	6.45		
Mean Gain Score	Control		7.87	7.15	-4.18	.00 (s)
	Experimental		18.00			

Note. significant at .05 level of significance

As shown in Table 1, before the intervention, Levene's test result (F= 0.14, p=0.71> 0.05) was not significant. This signifies that the two groups were comparable in their prior knowledge of the topic domain as their variance is not significant. Moreover, they perform remarkably low mean scores (20.40 vs. 21.20) before intervention. This is justifiable as both groups were not exposed to discussion or any method of teaching about the topic domain. Having almost the same mean scores was expected as they were exposed to the same teacher, strategies, and environment. Furthermore, most of the students had difficulty answering the conceptual understanding test, as they were asked multiple questions during the pretest.

The pretest t-test result (t= -0.48, p = 0.633> 0.05) indicates that statistically there was no significant difference between the control and experimental groups before the intervention which means both groups started with similar conceptual understanding levels.

After the intervention, Levene's test result (F=.56, p=0.46 > 0.05) was not significant, this implies that the variances of the two groups were comparable in conceptual understanding. Consequently, the posttest t-test (t = -4.85, p = 0.000 < 0.05) shows a statistically significant difference between the two groups after the intervention. This confirms that the experimental group performed significantly better than the control group after undergoing the intervention.

The lack of significant difference in the pretest suggests that both groups had equivalent baseline knowledge. The significant posttest difference demonstrates that the intervention had a strong and positive impact on the experimental group's learning outcomes.

This suggests that the experimental group outperforming the control group. This significant difference maybe explained due to the introduction of new teaching approach, specifically the Place-based inquiry teaching approach in the experimental group. The use of Place-based inquiry teaching approach had an impact to the students learning by uplifting their conceptual understanding in Biology

The finding of the study is in line with the results of Soares (2022) that there was a statistically significant difference between the content pretest and the content posttest in her study and the result implies that this approach is an effective in improving the conceptual understanding of the students and suggests that the linkage between Placed-based Education for Inquiry Learning in science is of considerable importance for science programs. Similarly, Dorji et al., (2021) revealed that students demonstrated increase in academic performance and intellectual capacity as a result of the hands-on learning experience through Place-based inquiry.

For the mean score, before the intervention, the results of the Conceptual Understanding Test (CUT) revealed that the control group obtained a mean score of score ($\bar{x}$=20.40), while the experimental group achieved a slightly higher mean score of ($\bar{x}$=21.20). The standard deviation (4.90) of experimental group suggests a slightly more variability than the control group's standard deviation (4.15). After the intervention, the control group's mean score increased to ($\bar{x}$=28.27), while the experimental group demonstrated a more substantial increase, with a post-test mean score of ($\bar{x}$=39.20). This higher increase in the students mean score in the experimental group might be due to the effectiveness of the use of Place-based inquiry teaching approach that helped to enhance the students understanding of the concepts in Biology. In terms of mean gain scores, the control group showed an average gain of ($\bar{x}$=7.87), whereas the experimental group had a significantly higher gain of ($\bar{x}$=18.00).

The slightly improvement in the experimental group's scores suggests that the Place-based Inquiry teaching approach was more effective than conventional teaching approach in enhancing students' conceptual understanding in Biology. By connecting scientific concepts to real-life, local contexts, Place-based Inquiry teaching approach likely made learning more meaningful and relevant, which helped students grasp and retain the content better. The higher mean gain and increased post-test performance point to deeper engagement and improved comprehension.

This is also similar to the findings of Khezang (2020) which found out that students taught using Place-based inquiry approach demonstrated

significant improvement on the learning of the research participants. It showed that the posttest increased compared to the pretest score, indicating the effectiveness of the approach. He also noted that this approach helped students' cognitive growth and making the learning process more meaningful and accessible.

By embedding learning within meaningful, real-life local contexts such as Place-based Inquiry approach likely facilitated this active construction of knowledge, enabling students to engage with concepts not just as isolated facts but as interconnected ideas with identifiable patterns and relationships. This approach promotes abstraction learning, where students internalize the underlying principles governing biological concepts, rather than relying on memorization of examples alone (Tan et al., 2020).

Moreover, Table 2 presents the distribution of students across low, moderate, and high conceptual understanding levels.

Table 2:
Numbers and Percentage Distributions of Control and Experimental Groups of Students in the Three Levels of Conceptual Understanding before and after Intervention

Raw score range	Conceptual Understanding level	Before Intervention		After Intervention	
		Control (n=15)	Experimental (n=15)	Control (n=15)	Experimental (n=15)
		Numbers (%)	Numbers (%)	Numbers (%)	Numbers (%)
0 -35	Less Developed	15 (100%)	15 (100%)	8 (53.3%)	1 (6.7%)
31-60	Developed	0 (0.0%)	0 (0.0%)	7 (46.7%)	14 (93.3%)
61-91	Well Developed	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Total	15 (100%)	15 (100%)	15 (100%)	15 (100%)

Note. Raw score range: 61-91 =Well developed; 31-60=Develop; and 0-30 Less developed

The presented table illustrates the level of conceptual understanding in both the pre-test and post-test for the control and experimental groups, categorized as less developed (0-30), develop (31-60), and well developed (61-91).

Before the intervention, all students in both groups were classified as having "Less Developed" conceptual understanding, with none scoring above 30. After the intervention, a marked difference was observed. In the experimental group, 93.3% of students advanced to the "Developed" level, while only one student remained in the "Less Developed" category indicating a significant improvement following the intervention. In contrast, the control group showed a more modest change: 46.7% of students reached the "Developed" level in the posttest, while 53.3% remained "Less Developed." No students in either group achieved the "Well Developed" category. These results suggest that the intervention had a meaningful impact on enhancing conceptual understanding in the experimental group.

The results imply that there is a positive impact of Place-based inquiry teaching approach on students' conceptual understanding, as evidenced by the clear contrast between the two groups. In the experimental group, the majority of students got 93.3% progressed from "Less Developed" to "Developed," demonstrating a strong response to the intervention. Only one student remained at the lower level, highlighting the effectiveness of the approach. Meanwhile, the control group showed a less pronounced improvement: less than half of the students (46.7%) advanced to the "Developed" category, while more than half (53.3%) stayed "Less Developed." This stark difference between the groups suggests that the intervention played a significant role in boosting conceptual understanding, whereas the control group's modest gains may reflect natural progression or other external factors. Notably, no students from either group reached the "Well Developed" level, indicating room for further growth beyond the current intervention.

The result supported by the study of L'Heureux et al. (2022) who stated that students exposed to the Place-based Inquiry Learning approach showed significantly greater progress in conceptual understanding compare to students in the control group. This is further supported by Baldwin (2021), who found that place-based learning fosters increased student motivation, deeper social awareness, and a stronger sense of connection to academic content. It emphasized that when students engage with their local environment and community issues, they are more likely to take ownership of their learning and remain engaged throughout the process.

Building on these findings, Jean Piaget's Cognitive Constructivism emphasizes that learners actively construct knowledge through direct interaction with their environment and reflective thinking. This theory views learning as a dynamic process, where students develop mental models based on their experiences rather than passively absorbing information. In the context of Place-based Inquiry, Piaget's theory supports the idea that students gained a deeper understanding of biological concepts by engaging directly with their local surroundings. For example, we conducted an activity where students observed a real-time food chain in the near-by gardens, such as a ladybug feeding on plants. By reflecting on these observations and sharing their insights at the end of the lesson, students went through the stages of assimilation and accommodation which are key processes in Piaget's theory. Thus, it enhances their conceptual understanding and critical thinking in biology.

Additionally, the reflective journals and qualitative interviews showed that students were able to articulate their learning more clearly and relate biological processes to familiar scenarios, demonstrating a deeper and more functional understanding of the concepts.

CONCLUSION

Based on the major findings, several important conclusions were drawn. Students who were not clearly taught the topic domains of Biology tended to lack adequate conceptual understanding, leading to a low level of mastery. However, their understanding significantly improved when key concepts and principles were taught explicitly through a localized, student-centered approach rooted in constructivist theory, such as the Place-Based Inquiry Teaching Approach (PBITA). Conceptual understanding, defined as the ability to comprehend and apply key ideas, enables learners to connect new information with their existing knowledge.

Furthermore, students not exposed to constructivist-based, contextually relevant learning strategies like PBITA showed minimal improvement over time. In contrast, those engaged in hands-on, inquiry-driven, and locally grounded learning experiences developed deeper conceptual connections and were able to apply theoretical knowledge in real-world contexts. Students who lacked a solid grasp of Biology concepts also performed poorly in open-ended assessments that required explanation or application of ideas.

Also, the study found that students lacking foundational conceptual knowledge scored lower in conceptual understanding assessments. Conversely, students who experienced the PBITA scored significantly higher in both posttests and mean gain scores. Qualitative findings further reinforced these outcomes by revealing that PBITA created a more engaging and positive learning environment, helping students find relevance and enjoyment in their Biology education.

Lastly, future researchers are encouraged to further investigate the challenges, limitations, and barriers to implementing the PBITA in various school contexts, particularly in areas with limited resources or difficult geographic conditions. Additionally, it is recommended that similar studies be conducted across other science subjects such as Earth Science, Physics, and Chemistry, and with larger and more diverse student populations to enhance the validity and generalizability of the findings.

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