ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166

Contextualization and Indigenization of Instructional Materials in Teaching Central Dogma of Molecular Biology

Rechel Flores-Meñoria [1], Julie S. Berame [2]
[1] Simbalan National High School, Buenavista, Agusan del Norte, Philippines
[2] College of Education, Caraga State University, Butuan City, Philippines

Abstract. This study aimed to develop and implement contextualized and indigenized instructional materials in teaching central dogma of molecular biology. A total of 38 grade 10 students participated in the study. Paired-samples t-test was used to compare the mean scores between pre-test and post-test. Results showed an increase in the students' level of knowledge after exposure to the instructional materials. There was an increase in mean scores of the pre- and post-test. It is further noted that the mean increase of around 2.71 during the post-test is statistically significant. Despite the significant increase in the scores of the students, challenges and issues experienced by the learners remained evident. Two relevant themes have emerged from the responses of the interviewed students. Some students are getting confused which is highly indicative of difficulty in getting started and hooked with the materials. Additionally, low foundation in requisites and basic concepts is another serious concern that hinders the effectiveness of the said instructional materials. The study concludes that contextualized and indigenized instructional materials are essential for better learning among indigenous learners.

Keywords: Central Dogma, Contextualization, Indigenization, Instructional Materials, Molecular Biology, Indigenous People

1. Introduction

One of the person's fundamental human rights is to achieve quality education [1]. That is why different countries in the world have an educational system that would answer the need of their citizen [2]. However, not all are given 'quality education' culturally rooted in the person's worldview [3]. The best example of this is the minorities and the Indigenous Peoples worldwide [4]. According to World Bank (2022), 476 million estimated Indigenous Peoples comprise 6% of the worldwide population, while 19% live in poor conditions. One of the reasons why they are still in a marginalized and disadvantaged situation is the lack of quality education. According to Cosentino as cited by Oxtero (2022), education for Indigenous Peoples should be "well-resourced, culturally sensitive, aligned with their learning needs, languages, priorities and aspirations, and delivered through culturally appropriate teaching strategies, and in culturally appropriate settings [4].

Indigenous students might encounter a range of difficulties when it comes to grasping intricate scientific ideas like the central dogma of molecular biology (DNA → RNA → Protein). The Central Dogma of Molecular Biology stands as an iconic framework that unfurls the intricate choreography governing the flow of genetic information within living organisms. Originating from the visionary insights of Francis Crick in 1958, this paradigm illuminates the journey of genetic code, beginning with the replication of DNA, traversing through the transcription of genetic templates into RNA, and culminating in the translation of RNA sequences into functional proteins [7]. This concept involving molecular and cellular mechanisms that are presented as still pictures in textbooks, and the available teaching materials that can promote active learning are underutilized [8][9].

Understanding this topic at the secondary level is essential and precursor to other higher concepts in biology, and to be able to connect biological processes happening at the cellular and organismal levels [8]. While this topic is regarded as core to the discipline, many teachers and learners are facing the burden of understanding its highly abstract concepts. Hence, it remains difficult to teach, and least mastered among teachers and learners, respectively. Many authors conveyed that this is due to the complexity of the topic's underlying concepts that are not available for direct observations [9].

ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166
Hence, educators, teachers, and policymakers have embraced contextualization as a constructivist approach and an inquiry-based teaching practice that bridges the gap between concepts and real-life experiences [10]. Contextualized approach is one aspect of constructivist approach that focuses on the relevancy of the curriculum and instructional strategies to learners' context [11] [12]. Contextualization can involve several elements, such as interdisciplinary learning, incorporating students' informal knowledge from outside of school, teachers working together to highlight real-world examples, and promoting student collaboration and active learning [13].

The current study emphasized the use of contextualized instruction to make difficult science concepts more meaningful to students by drawing on their existing knowledge and everyday experiences. This research endeavors creates a customized and culturally adapted resources on the Central Dogma of Molecular Biology for Grade 10 science due to findings showing students' limited comprehension of this concept [14]. It is crucial for the researcher to enhance the current learning resources utilized by grade 10 students in science to align with their requirement of comprehending Grade 10 Science concepts in the K to 12 Basic Education Curriculum. Additionally, the researcher will delve further and attempt to determine the effectiveness of the Contextualized Materials created for grade 10 students based on their Pre/Post test scores.

2. Research Method

This research was performed by quasi-experimental and descriptive qualitative method with the used of thematic analysis. Experimental research [15] is an experiment conducted and accompanied by one treatment or action, then assessed using an instrument to see, analyze, evaluate and test hypotheses. Descriptive research is research conducted to determine the value of independent variables, either one or more variables (independent) without making comparisons or connecting between variables with each other [16]. Qualitative data is data expressed in the form of words, sentences, and images. Common techniques used by qualitative researchers is the thematic analysis which involves the identification of recurring patterns that are presented by researchers as overarching statements or themes [17].

The participants of this study were mainly selected based on purposive sampling technique. It was a nonprobability sampling technique in which the researcher carefully selected the sample while ensuring the purpose of the study, with the assumption that each participant will be able to provide specific and rich data that are important to the study [18]. One (1) section of Grade 10 learners of Simbalan National High School was chosen as the participants of the study. This was for the reason that the researcher had direct supervision on them. This was done to minimize the disruption of classes and other conflicts that might arise in the conduct of the study.

The researcher used three research instruments: the Contextualized and indigenized Materials, the Pretest/Posttest assessment tool and Interview Questionnaire. The materials were prepared and developed by the researcher and validated by three experts from the Department of Education. The rating of passed in all criteria are obtained after the validation.

3. Results and Discussion

This section presents the results of the study based on the data gathered after the implementation of the developed instructional materials. Significant findings are presented according to the chronological order of the problem statements.

3.1 Knowledge Level of Students on the Topic Central Dogma of Molecular Biology in Terms of Pretest and Postest

Table 1 presents the frequency and percentage distribution of the students according to their pre-test and post-test scores. It can be noted that during pre-test, where the students are not yet exposed to the developed IMs, 29% (11) displayed a developing level of knowledge while 45% (17)

ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166
posited an approaching proficiency level. In addition, 24% (9) of the students showed proficiency level and 3% (1) was found advance in knowledge about Central Dogma of Molecular Biology.

Table 1. Distribution of students in terms of knowledge level on the topic Central Dogma of Molecular Biology

Score Intervals	Knowledge Level	Pre-test	Post-test
0-3	Beginning	0% (0)	0% (0)
4-7	Developing	29% (11)	11% (4)
8-11	Approaching Proficiency	45% (17)	39% (15)
12-15	Proficient	24% (9)	24% (9)
16-20	Advance	3% (1)	26% (10)

On a different note, improvement on knowledge to the same topic is indicated in the post-test scores. A percentage share of 26% (10) is accounted to the students who demonstrate an advance level of knowledge compared to only one student during pre-test. In addition, the proportion of students in developing level decreases to 11% (4) which is 29% (11) in pre-test. The percentage of students with proficient knowledge remained 24% (9) while the remaining 39% (15) showed an approaching proficiency level of knowledge to the same topic in the post-test. Moreover, it can be observed that in both pre-test and post-test, none of the students obtained scores that fall within a descriptive level of beginning.

Actual experiences in the classroom can speak of the reality regarding the knowledge level of the students in science subject in general [19] . Many of the students are usually developing or approaching proficiency when it comes to their understanding on several lessons including the Central Dogma of Molecular Biology [11]. It was similarly observed that many high school students find it hard to understand science lessons more particularly with the usual lecture or conventional teaching approaches [20] . More particularly for IP learners [4] asserted that conventional approaches to teaching are not tailor-fit to learning styles of indigenous learners. Instead, effective instructional approaches for IP should be sufficiently designed to their learning preferences, languages, priorities, and aspirations, and delivered using culturally relevant teaching methods and in suitable environments [8]. Much research shows that when educational curricula and pedagogy are imbued with Indigenous knowledge and ways of knowing, Indigenous student learning improves [21].

With the use of the contextualized and indigenized IMs, post-test scores strongly signify for the improvement in the level of knowledge of the students particularly on the topic Central Dogma of Molecular Biology [20]. This is particularly evidenced by the increase in the number of students who showed an advance level of knowledge in the post-test [20]. Relative to the literature [7] that contextualized and indigenized instructional materials can significantly enhance the performance of Indigenous high school students in science by making the content more relevant and relatable to their cultural backgrounds [7]. By incorporating local knowledge, traditions, and ways of understanding the world, these materials create a bridge between students' lived experiences and academic learning [22]. For example, instead of solely teaching scientific concepts from a Western perspective, instructional materials can include local ecological knowledge, Indigenous storytelling, or traditional practices that align with scientific principles [23].

ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166

3.2 Significant Difference in the Performance of the Participants During the Pretest and Posttest

Table 2 posits the paired t-test results showing the mean gain or mean increase in the scores of the students after being exposed to the contextualized and indigenized IMs. Before presenting a detailed discussion of the statistical results in table 2, it is essential to note that the descriptive statistics shown in table 1 have already provided relevant overview of the improvement of students' knowledge with the use of the mentioned IMs.

As an inferential statistical test to strengthen the quantitative evidence regarding the claimed increase in the scores when utilizing the contextualized and indigenized IMs, data were first subjected to normality test. Shapiro-Wilk test showed further unfolds that data are normally distributed and paired t-test is found appropriate for the test on mean difference.

Table 2. Paired t-test results showing the mean difference between the pre-test and post-test scores of the students

Test Setting	Mean	Standard Deviation	Mean Difference	P-value	Remarks
Pre-test	9.79	3.07	2.71	<0.001	Significant
Post-test	12.50	4.10			

Note: Shapiro-Wilk test results showed that data are normally distributed

More specifically, students have shown a mean score of 9.79 in pre-test which is lower than the post-test mean score of 12.50. It indicates that the same students have gained a mean increase of 2.71. As evidenced by the very small p-value < 0.001, the notable increase in the mean is statistically significant. Thus, it leads to a statistical decision to reject the study's null hypothesis and conclude that mean score in the post-test is significantly higher than in the pre-test.

Definitely, table 2 provides substantial evidence regarding effectiveness of the contextualized and indigenized IMs in teaching Central Dogma of Molecular Biology among IP learners. Similar results explaining that utilizing constructivist methods improved the comprehension and memory of molecular biology concepts when linked to practical, real-world examples [24] . Definitely, the Central Dogma, which explains how genetic information is transferred from DNA to RNA to proteins, can be abstract and challenging for students who may not have prior exposure to Western scientific frameworks [25] . By incorporating traditional knowledge, such as storytelling or metaphors rooted in nature, educators can simplify these concepts in a way that resonates with IP learners [26]. For instance, teachers could use analogies from local ecological systems—like how information is passed between generations of animals or plants—to illustrate the transfer of genetic information, making the concept more intuitive and culturally relevant [27].

In addition, indigenized IMs can help build connections between the Central Dogma and Indigenous knowledge systems, fostering a deeper understanding and appreciation of biology [22]. Many Indigenous communities have long recognized the interconnectedness of life, where each organism plays a crucial role in the larger ecosystem, much like how the components of the Central Dogma work together in molecular biology [28] . By drawing parallels between these scientific processes and Indigenous worldviews—such as the holistic understanding of life and nature—students can see the relevance of scientific principles to their own lives [23] . This approach not only demystifies molecular biology but also empowers Indigenous learners by demonstrating that their cultural perspectives can contribute to and enrich scientific learning, thereby increasing engagement and knowledge retention [29]. A study in the United States further explained that the contextualized instructional strategies ensure active engagement of learners in their own construction of knowledge and understanding the concept with the ability to draw examples and apply theoretical concepts in real life contexts [14].

ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166

3.3 Acceptability Level of Contextualized and Indigenized IMs on the Following Criteria, Objectives, Content, Material, Instructional Quality, and Assessment

To check the level of acceptability of the contextualized and indigenized IMs on the topic Central Dogma of Molecular Biology, table 3 exposes the results from experts' scores on several criteria of IMs evaluation based on DepEd standards. Using the mean quantification specified in the methodology section, the descriptive acceptability level of the IMs across five criteria namely; Objectives, Content, Material, Instructional Quality, and Quality Assessment are highly remarkable. All experts have commonly agreed that the developed IMs are highly acceptable relative to the known standards.

Table 3. Acceptability level of the contextualized and indigenized IMs

Acceptability Criteria	Validator 1	Validator 2	Validator 3	Overall	Acceptability Level
Objectives	4.40	5.00	5.00	4.80	Highly Acceptable
Content	4.50	5.00	5.00	4.83	Highly Acceptable
Material	4.44	5.00	5.00	4.81	Highly Acceptable
Instructional Quality	4.30	5.00	5.00	4.77	Highly Acceptable
Assessment	4.50	5.00	5.00	4.83	Highly Acceptable

As displayed in table 3, the overall mean ratings given by the validators in all criteria statistically support for a highly acceptable IMs. In terms of objectives, validator 1 posits a mean score of 4.40 while validators 2 and 3 yielded perfect mean scores of 5.00. In effect, an overall mean of 4.80 describes for a highly acceptable IMs in terms of objectives. As to content, the given table consistently showed a high level of acceptability among experts. This is specifically evidenced by the overall mean of 4.83 which is explained by the respective mean ratings of 4.50, 5.00, and 5.00 for validators 1, ,2, and 3.

Similar trend of experts' ratings is noted in terms of material. Validator 1 still posits the lowest mean of 4.44 while the other validators rated a perfect mean score of 5.00. Consequently, the overall mean of 4.81 statistically implies for a highly acceptable IMs in terms of material. Dealing with instructional quality, validator 1 still rated the lowest mean of 4.30 but perfect mean scores from validators 2 and 3. As a result, overall mean of 4.77 describes for a highly acceptable IM in terms of instructional quality.

Consistent to the first four criteria presented above, the contextualized and indigenized IMs are highly acceptable to the evaluation of the experts as shown in the given table 3. More specifically, validator 1 remained lowest with the mean score of 4.50 while validators 2 and 3 similarly scored the same criterion with a rating of 5.00. In effect, the overall mean of 4.83 empirically establishes that the contextualized and indigenized IMs are highly acceptable when it comes to consistency aspect.

Findings presented in table 3 shows coherence in several studies which described that contextualized and indigenized IMs for IPs are highly acceptable, valid, and reliable as long as standards and procedures are considered [30][31]. In another study of Nikos and Economou (2020), it was underscored that contextualized and indigenized instructional materials (IMs) are highly

ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166
acceptable to Indigenous peoples (IPs) because it honors and reflects the cultural identities, values, and knowledge systems of Indigenous communities [32]. For many Indigenous students, mainstream educational content often feels distant or irrelevant because it does not recognize their traditions, languages, or worldviews [33] . By integrating local cultural references, Indigenous languages, and community-specific knowledge, these instructional materials resonate with students on a personal level [34]. They create a sense of inclusion and recognition, making students feel that their culture is valued within the educational system [35]. This respect for their heritage fosters positive attitudes toward learning and increases student engagement [36]. Thus, the science curriculum may be enriched with situated approaches to establish relevant and meaningful science education that relates to all learners and embraces not only their culture but also their individuality and applying contextualized lessons in biology pedagogy narrows the gap between classroom instruction and learner diversity, creating a more inclusive, situated, relevant science education that can last a lifetime [37].

3.4 Issues and Challenges in Implementing Contextualized and Indigenized Materials

Challenges and issues in the implementation of the contextualized and indigenized learning materials remained evident inspite of the positive increase in the mean scores of the students. Table 4 shows the emergence of the relevant themes that describe the said challenges and issues experienced by the students.

Table 4. Thematic analysis results showing the emergence of thematic challenges and issues encountered by the students

Actual Response	Codes	Frequency	Theme
Coconut leaves may have different meanings and uses in different culture which affect my learning	Getting confused with the material	20	Difficulty in getting started and hooked with the material
It’s hard for me to grasp at first			
It needs effort to understand the whole process while using the materials			
It's difficult for me to understand because I don't have enough background on the topic	Poor knowledge foundation	18	Low foundation in requisites and basic concepts

No. of Participants: 38

Difficulty in getting started and being hooked with the lessons from the material seemed to be a hurdle to the interviewed students. It emanates from the fact that these learners are getting confused on how to navigate the material with some ambiguities in the use of figures or pictures. For example, one of the students said; “Coconut leaves may have different meanings and uses in different culture which affect my learning”. It indicates further that the use of images in the IMs should be relevant to the culture and experiences of the IP students. Another student revealed that it was very hard to grasp the lesson at the start. It took significant amount of time to finally understand the lesson and continue with the whole IMs. Moreover, a different student also mentioned that “It needs effort to understand the whole process while using the materials”. This is a supporting manifestation of the issues or difficulties of the learners on how to easily and conveniently start with the IMs.

The second emerging theme describes the students’ low foundation on the essential requisites and basic concepts. This is highly signified in the statement of a student who said that; “It's difficult for me to understand because I don't have enough background on the topic”. Definitely, the

ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166
relatively poor foundation in any lessons are important predictors of better understanding to advance topics. This specific finding unfolds the reality for a need to constantly ensure that all essential pre-requisites are achieved before proceeding to the main topics that are expected in the contextualized and indigenized IMs for all lessons in Biology.

When it comes to studies in the literature, the difficulties that indigenous learners face in getting started with and staying engaged in instructional materials are multifaceted, involving a mix of cultural, linguistic, historical, and social factors [38] . Definitely, one of the spotted gaps is that indigenous students may struggle to relate to materials that don't reflect their cultural values, lived experiences, or ways of knowing [38]. When the content is based on Western perspectives and lacks relevance to their everyday lives, students may find it harder to engage or see the value in the materials [36]. Another essential consideration is language barriers further complicate the learning process for indigenous students [39]. Many indigenous learners speak their native languages at home, and these languages may not be represented in the materials or may be inappropriately represented by unnecessary images [39].

Moreover, the low foundation of the learners on the basic requisites in Biology lessons is a common problem in science [40]. A low foundation in basic science concepts presents a significant challenge for indigenous learners, even with the presence of contextualized learning materials [6]. Many indigenous students may not have been exposed to foundational scientific principles in earlier education due to disparities in access to quality education and resources in their communities [41]. Without a solid grasp of basic concepts such as measurement, observation, or the scientific method, learners may find it difficult to understand more advanced topics, regardless of how well the materials are adapted to their cultural context [42]. Even though contextualized learning materials are designed to make science more relevant to indigenous students by tying lessons to their cultural experiences, they may not always address the root issue of basic conceptual understanding [43].

4. Conclusion

The use of contextualized and indigenized IMs on the topic Central Dogma of Molecular Biology contributed to the advancement in the level of knowledge among IP students. Considering DepEd standards on the acceptability of IMs, the study showed that the contextualized and indigenized IMs on the topic Central Dogma of Molecular Biology is highly acceptable. Inferential statistics results provide strong coherence to Vygotsky's theory and similar findings in the literature regarding the essence of contextualized and indigenized IMs for the advancement of IP students' knowledge in all possible topics of Biology and other sciences. Definitely, the study yielded sufficient evidences that the developed contextualized and indigenized IMs on the topic Central Dogma of Molecular Biology is highly effective and acceptable. Difficulties in getting started with the materials and poor knowledge foundation are important areas for improvement that must be considered in the furtherance of the benefits of utilizing the developed contextualized and indigenized IMs on the topic Central Dogma of Molecular Biology.

5. Acknowledgements

The authors expressed their heartfelt gratitude to the student-participants in the Department of Education for their active participation in the conduct of the study.

6. REFERENCES

[1] UNESCO, "What you need to know about the right to education," Apr. 2023.

[2] Joel Westheimer and Gloria Ladson-Billings., "What Kind of Citizen?: Educating Our Children for the Common Good," 2nd ed., Teachers College Press, Amsterdam, Avenue, New York, NY, 10027, 2024.

ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166
[3] R. W. Marpaung, S. B. Sinaga, and S. Womsiwor, "Inclusive Education Curriculum Development for Indigenous Students in Papua," SHS Web of Conferences, vol. 149, p. 01023, 2022, doi: 10.1051/shsconf/202214901023.

[4] Irish Angcao Oxtero, "Implementation of Indigenous Peoples (IPEd) Program in Agusan del Sur: A Case Study," Asian Journal of Research in Education and Social Sciences, vol. 4 No.2, pp. 76–90, Jun. 2022, doi: 10.55057/ajress.2022.4.2.8.

[5] J. M. Saro, J. B. Bello, L. S. Concon, and R. D. Manlicayan, "Contextualized and Localized Science Teaching and Learning Materials and Its Characteristics to Improve Students' Learning Performance," vol. 7, pp. 77–84, Feb. 2023, doi: 10.5281/zenodo.7607686.

[6] M. Tabotabo-Picardal and J. D. Paño, "Facilitating Instruction of Central Dogma of Molecular Biology through Contextualization," Journal of Teacher Education and Research, vol. 13 No. 2, no. 2, pp. 118–132, Jan. 2018, doi: 10.5958/2454-1664.2018.00012.5.

[7] J. S. Cano, "Development and Validation of Simulation-Based Instructional Materials on Central Dogma of Molecular Biology for Senior High School," International Journal of Technology in Education and Science, vol. 6, no. 2, pp. 373–387, May 2022, doi: 10.46328/ijtes.368.

[8] M. G. R. Gilissen, M. C. P. J. Knippels, and W. R. van Joolingen, "Fostering students' understanding of complex biological systems," CBE Life Sci Educ, vol. 20, no. 3, Sep. 2021, doi: 10.1187/cbe.20-05-0088.

[9] J. S. Cano, P. R. Olvis, B. Y. Disca, and A. F. Docena, "Simulation-Based Instructional Materials on Central Dogma of Molecular Biology: Basis in Studying Genetics for Grade 12 Learners," International Journal of Technology in Education, vol. 5, no. 2, pp. 249–268, May 2022, doi: 10.46328/ijte.219.

[10] M. T. Picardal and J. M. P. Sanchez, "Effectiveness of Contextualization in Science Instruction to Enhance Science Literacy in the Philippines: A Meta-Analysis," Jan. 01, 2022, Society for Research and Knowledge Management. doi: 10.26803/ijlter.21.1.9.

[11] P. Tshojay and N. Giri, "Contextualized approach in teaching Chemistry: The perspectives and practices of teachers and students," 2021. [Online]. Available: www.visnav.in/ijacbs/

[12] M. Palmieri, D. Trugillo, and M. Fontes, "Are there any Dominant Theoretical Frameworks for Contextualization in School Science Textbooks?", doi: 10.46328/ijres.65.

[13] R. A. Maravilla and J. V. Aliazas, "Contextualized Activity Tool For Enhancing Grade 7 Science Competencies," Int J Sci Adv Res Technol, vol. 10, no. 2, pp. 11–28, Feb. 2024, doi: DOI:10.5281/zenodo.10616951.

[14] E. Davidsson and P. Granklint-Enochson, "Teachers' Way of Contextualizing the Science Content in Lesson Introductions," Science Education International, vol. 32, no. 1, pp. 46–54, 2021, doi: 10.33828/sei.v32.i1.5.

[15] B. Rikardo Parhusip, T. Wisnu Saputra, and I. Marko Ayaki, "Implementation of Project Based Learning by SolidWorks Application in Online Learning during the COVID-19 Pandemic," Am J Educ Res, vol. 9, no. 7, pp. 431–434, Jul. 2021, doi: 10.12691/education-9-7-6.

[16] S. Chadijah, N. Syariatin, Y. Rohmiyati, J. Utomo, and A. Y. Rukmana, "A Correlational Study of Gadget Used Towards Reading Interest," Journal of English Culture, Language, Literature and Education, vol. 11, no. 1, pp. 59–78, Mar. 2023, doi: 10.53682/eclue.v11i1.6056.

[17] C. R. Lochmiller, "Conducting thematic analysis with qualitative data," Qualitative Report, vol. 26, no. 6, pp. 2029–2044, Jun. 2021, doi: 10.46743/2160-3715/2021.5008.

[18] F. MULİSA, "Sampling techniques involving human subjects: Applications, pitfalls, and suggestions for further studies," International Journal of Academic Research in Education, vol. 8, no. 1, pp. 74–83, Dec. 2022, doi: 10.17985/ijare.1225214.

[19] A. Kervinen, W. M. Roth, K. Juuti, and A. Uitto, "The resurgence of everyday experiences in school science learning activities," Cult Stud Sci Educ, vol. 15, no. 4, pp. 1019–1045, Dec. 2020, doi: 10.1007/s11422-019-09968-1.

[20] A. Buban, "DIFFICULTIES IN LEARNING SCIENCE: BASIS FOR INTERVENTION,"Oct. 2023. [Online]. Available: https://www.researchgate.net/publication/374949882

[21] J. P. Preston and T. R. Claypool, "Analyzing Assessment Practices for Indigenous Students," Jul. 16, 2021, Frontiers Media S.A. doi: 10.3389/feduc.2021.679972.

ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166
[22] G. T. Flores and S. P. Obod, "Assessment of Text-Based Instructional Materials Used Among Indigenous Peoples (IP) Learners in a New Normal Classroom," International Journal of Membrane Science and Technology, vol. 10, no. 3, pp. 99–110, 2023, doi: https://doi.org/10.15379/ijmst.v10i3.1320

[23] R. Zidny, J. Sjöström, and I. Eilks, "A Multi-Perspective Reflection on How Indigenous Knowledge and Related Ideas Can Improve Science Education for Sustainability," Sci Educ (Dordr), vol. 29, no. 1, pp. 145–185, Feb. 2020, doi: 10.1007/s11191-019-00100-x.

[24] L. M. Maglinte and L. B. Coronica, "Effectiveness of constructivist e-learning module in General Biology," Sapienza, vol. 4, no. 4, Oct. 2023, doi: 10.51798/sijis.v4i4.704.

[25] K. A. Sharp, R. M. N. Krall, and J. Chalfant, "Deepening Undergraduate Students' Thinking about Central Dogma through Problem-Based Learning," Educ Sci (Basel), vol. 13, no. 9, Sep. 2023, doi: 10.3390/educsci13090854.

[26] C. da Silva, F. Pereira, and J. P. Amorim, "The integration of indigenous knowledge in school: a systematic review," Compare, 2023, doi: 10.1080/03057925.2023.2184200.

[27] N. Rüya, T. Bedizel, and N. Azizoğlu, "Analogies Used in a General Biology Course: How is DNA Conserved Across Generations?," J.Sci.Learn.2023, vol. 6, no. 4, pp. 374–386, 2023, doi: 10.17509/jsl.v6i4.57909.

[28] N. M. Dawson et al., "The role of indigenous peoples and local communities in effective and equitable conservation," Ecology and Society, vol. 26, no. 3, 2021, doi: 10.5751/ES-12625-260319.

[29] R. El Yazidi and K. Rijal, "Science Learning in the Context of 'Indigenous Knowledge' for Sustainable Development," International Journal of Ethnoscience and Technology in Education, vol. 1, no. 1, p. 28, Feb. 2024, doi: 10.33394/ijete.v1i1.10880.

[30] S. Md Yusof, "Vygotsky Sociocultural Theory of Child Development: More Knowledgeable Other (MKO) and the Zone of Proximal Development (ZPD)", doi: 10.13140/RG.2.2.35985.40804.

[31] D. H. Williams and G. P. Shipley, "Indigenous Research Methodologies: Challenges and Opportunities for Broader Recognition and Acceptance," Open J Soc Sci, vol. 11, no. 05, pp. 467–500, 2023, doi: 10.4236/jss.2023.115030.

[32] E. M. Abad, "Development and Evaluation of a Contextualized Reference Material in Social Studies." [Online]. Available: www.ajhssr.com

[33] M. P. Mavuso, B. E. Olawale, and N. Mkosi, "Integration of Indigenous Knowledge in the Intermediate Phase Curriculum: a case of South African Schools," in Research Papers on Knowledge, Innovation and Enterprise KIE Conference Procedding, Jul. 2021, pp. 7–9. [Online]. Available: https://www.researchgate.net/publication/353444393

[34] C. Seerangan and R. V. Ravi, "INTEGRATING TRADITIONAL KNOWLEDGE WITH MODERN EDUCATION IN THE KOLLI HILLS," International Journal of Business and Administration Research Review, vol. 10, no. 2, Jul. 2024, [Online]. Available:www.ijbarr.com

[35] Chima Abimbola Eden, Onyebuchi Nneamaka Chisom, and Idowu Sulaimon Adeniyi, "CULTURAL COMPETENCE IN EDUCATION: STRATEGIES FOR FOSTERING INCLUSIVITY AND DIVERSITY AWARENESS," International Journal of Applied Research in Social Sciences, vol. 6, no. 3, pp. 383–392, Mar. 2024, doi: 10.51594/ijarss.v6i3.895.

[36] K. N. Mpuangnan and S. Ntombela, "Community voices in curriculum development," Curriculum Perspectives, vol. 44, no. 1, pp. 49–60, Apr. 2024, doi: 10.1007/s41297-023-00223-w.

[37] M. G. Garlan, "EXPLORING COMMUNITY FUNDS OF KNOWLEDGE TO DEVELOP CONTEXTUALIZED BIOLOGY LESSON PLAN EXEMPLARS FOR K-12 INSTRUCTION," 2018.

[38] N. B. Buenaflor, "The Lived Experiences and Challenges Faced by Indigenous High School Students Amidst the New Normal of Education," 2023, doi: 10.5281/zenodo.7652948.

[39] A. J. Leaño, N. Mat Rabi, and G. Annammal Gnana Piragasam, "SPEAKIN DIFFICULTIES OF PHILIPPINE INDIGENOUS LEARNERS IN ENGLISH SEMANTICS," Southeast Asia Early Childhood Journal, vol. 8, no. 2, pp. 16–27, Nov. 2019, [Online]. Available: http://ejournal.upsi.edu.my/index.php/SAECJ

ISSN:3007-9659 DOI: https://doi.org/10.70114/ahmer.2025.2.1.P166
[40] J. T. D. Santos, R. Lim, and D. V. J. Rogayan, "Least mastered competencies in biology: Basis for instructional intervention," JPBI (Jurnal Pendidikan Biologi Indonesia), vol. 7, no. 3, pp. 208–221, Oct. 2021, doi: 10.22219/jpbi.v7i3.17106.

[41] J. P. Eduardo and A. G. Gabriel, "Indigenous Peoples and the Right to Education: The Dumagat Experience in the Provinces of Nueva Ecija and Aurora, in the Philippines," Sage Open, vol. 11, no. 2, 2021, doi: 10.1177/21582440211009491.

[42] Nikolay Popov et al., New Challenges to Education: Lessons from Around the World, vol. 19. BCES Conference Books, 2021.

[43] J. M. Saro and J. B. Bello, "Contextualized and Localized Science Teaching and Learning Materials and Its Characteristics to Improve Students' Learning Performance," 2023, doi: 10.5281/zenodo.7607686.