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Research Article

Project-based Lessons in Teaching and Learning Biodiversity

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ABSTRACT

The study aimed to develop and evaluate Project-Based Lessons in Biodiversity for Grade 8 asynchronous learners at Daraga National High School, integrating them into the Rotation Model of Blended Learning. Specifically, it sought to determine the features of effective project-based lessons, assess student-created outputs demonstrating 21st-century skills, and evaluate the effectiveness of these lessons in enhancing content knowledge, values, and attitudes. Using a descriptive research method, qualitative data were gathered through expert evaluations, student journals, interviews, focus group discussions, and attitude checklists. Eleven experts, trained in the Project-Based Approach, validated the lessons and instruments, while forty Grade 8 students participated in the implementation. Findings indicated that the developed lessons were student-centered, contextualized, collaborative, and incorporated differentiated tasks. They enabled experiential learning, real-world connections, and the use of accessible materials. Students worked in groups with assigned roles, enhancing teamwork and responsibility. Differentiated tasks accommodated diverse learning abilities, fostering independent learning. Student outputs, such as species collages, biodiversity maps, and explainer videos, demonstrated critical thinking, communication, collaboration, and creativity. The lessons were highly effective in improving content knowledge, as well as fostering values like stewardship, accountability, and honesty, alongside positive attitudes such as perseverance and curiosity. The study concluded that the developed project-based lessons aligned with best practices in student-centered learning and significantly contributed to skill and value development. It recommended expanding project-based lessons to other science topics and grade levels, integrating them across curricula, and conducting further studies for continuous improvement.

Keywords: Project-based lessons; Biodiversity education; Blended learning; 21st-century skills development; Rotation model, Effective teaching strategies; Student-centered learning

1. INTRODUCTION

The COVID-19 pandemic disrupted daily activities, including education, prompting the Philippine government to suspend physical classes and adopt remote learning to ensure safety. This shift led to challenges in delivering quality education, particularly in basic education, addressed by the Department of Education's Basic Education Learning Continuity Plan (BE-LCP). The implementation of various flexible learning modalities, including distance and hybrid learning, aimed to continue education despite the pandemic's restrictions.

At Daraga National High School, the transition from face-to-face learning to online and hybrid modalities was a significant change, requiring extensive planning and adjustments. Technological advances, such as online learning platforms and digital tools, played a vital role in enabling education to continue. Hybrid learning, a blend of traditional methods and technology, emerged as an effective solution, allowing students flexibility in their learning experience. This approach promotes critical 21stcentury skills such as collaboration, communication, and creativity.

Project-Based Learning (PBL) is an effective pedagogical approach that supports the development of these skills. It fosters student-centered, collaborative, and contextualized learning, where students engage in meaningful projects over extended periods. This study focuses on the use of Project-Based Lessons to teach biodiversity in Grade 8, an area where students previously exhibited low mastery. The research aims to explore how project-based lessons in biodiversity can enhance student understanding of scientific concepts, as well as their values and attitudes, in a hybrid learning environment.

Statement of the Problem

This study developed Project-based lessons for teaching and learning biodiversity in the context of hybrid learning delivery modalities. Specifically, it aimed to answer the following sub-problems:

1. What Project-based lessons in biodiversity may be developed with the following features: a. Student-centered
   b. Contextualized
   c. Collaborative
   d. Using differentiated tasks
2. What are the outputs created by the students that demonstrated: a. Critical thinking
   b. Communication
   c. Collaboration
   d. Creativity
3. How effective are the developed Project-based lessons in the development of students' a. Content knowledge
   b. Values and attitudes

The study sought to assess the effectiveness of the developed Project-based lessons in improving students' understanding of biodiversity, enhancing their 21st-century skills, and fostering positive values and attitudes. By using a hybrid learning approach, this research aimed to evaluate how well these lessons could facilitate meaningful learning in the context of the pandemic and beyond.

2. MATERIALS AND METHODS

The study employed a descriptive research design and highly qualitative method research approach with highly qualitative procedures to gather results to answer the problems presented using descriptive and thematic analysis methods. This research methodology is suitable to this study since it allows the researcher to seek in-depth phenomena in a natural setting. Since the natural setting of this study is affected by the current situation where there are no face-to-face classes yet, the chosen methodology focused on the direct experience of the respondents during their teaching-learning experience using project-based lessons. The chosen methodology is particularly suitable for this study, as it allows for an in-depth analysis of student experiences in a natural setting, which is vital for understanding the nuances of learning in an asynchronous, non-face-to-face environment. Given the constraints imposed by the ongoing pandemic, the research focused on students' direct experiences with project-based learning, using various qualitative tools to explore the impact of the lesson plans.

To answer the research questions, descriptive analysis was employed to summarize the students' experiences with the developed project-based lessons. Additionally, thematic analysis was used to identify recurring themes related to students' content knowledge, skills, values, and attitudes developed through the lessons. This process involved gathering data from several sources, including focus group discussions (FGDs), semi-structured interviews, checklists, surveys, and reflective journals. These qualitative data were analyzed to uncover deeper insights into the students' learning processes and outcomes.

Sources of Data

The primary data sources for this study were the outputs of a group of Grade 8 students from Daraga National High School, specifically those who participated in asynchronous classes during the school year 2021-2022. These learners, who were enrolled in an online and offline modality due to the pandemic, served as the main subjects of the study. Data collection involved multiple instruments:

- Focus Group Discussions (FGDs) and semi-structured interviews with students provided qualitative insights into their experiences and perceptions of the Project-based lessons.
- Checklists, values and attitudes surveys, student logs, and exit tickets were employed to assess the students' content knowledge, 21st-century skills development, and the values and attitudes exhibited throughout the learning process.
- Students' journal entries were another key data source, capturing students' reflective thoughts and experiences as they engaged with the project-based lessons. These journals documented the students' learning journey over several weeks, allowing for an analysis of how their understanding of biodiversity evolved.

Additionally, data were gathered from expert evaluations of the Project-based lessons and the students' outputs, which further enriched the findings. Secondary sources, including books, academic journals, and online resources, were consulted to provide context and support for interpreting the findings.

Respondents

The study employed purposive sampling, where the researcher selected participants based on specific characteristics relevant to the study. In this case, the respondents were 40 Grade 8 students enrolled in the asynchronous modality at Daraga National High School for the academic year 2021-2022. These students were selected because they represented a diverse range of learners who had chosen the online learning format due to the pandemic, and were expected to have varying levels of engagement with the subject matter. The learners were selected based on their ability to access online resources and participate in the online lessons, as they had the necessary devices and internet connectivity.

The decision to focus on Grade 8 students was made because they are typically at a developmental stage where they are learning new concepts in science, such as Biodiversity, and have limited prior exposure to the topic. Given that the students had not received in-depth instruction on Biodiversity in previous school years due to the disruption caused by the pandemic, their responses were critical for understanding how Project-based lessons could effectively address gaps in their knowledge.

In addition to the student respondents, the researcher sought the assistance of eleven Project-based learning experts and ten subject teachers (including Science and other subject teachers) to validate the developed project-based lessons and assess students' outputs. These experts were selected based on their expertise in creating and delivering Project-based learning activities. Their feedback on the lesson plans ensured the lessons were relevant, engaging, and aligned with best practices in pedagogy. Furthermore, the teacher assessors evaluated the students' projects to determine if they demonstrated 21st-century skills and appropriate values and attitudes.

Instruments

The data collection process utilized multiple instruments, all designed to capture various aspects of student learning and experience. These tools were carefully selected and validated by experts to ensure their reliability and relevance for the study. The following instruments were used:

1. Project-based Lessons Validation Tool

This tool was designed to evaluate the developed lessons against key principles of effective Project-based learning. Adapted from the work of Gina Basmayor (2019), this validation tool helped the researcher assess whether the lessons effectively fostered the development of 21st-century skills among students. It contained a range of indicators focused on the design, implementation, and expected outcomes of Project-based lessons.

2. Student's Journal

Each student was asked to maintain a journal throughout the duration of the study. The journal consisted of 8 reflective prompts related to the students' experiences with the Project-based lessons. It captured their thoughts on the lesson content, teamwork, challenges faced, and skills developed. The journals were submitted weekly and were used to gauge the students' understanding of the material, including the enhancement of their content knowledge, values, and attitudes. Students completed four journal entries corresponding to the four Project-based lessons conducted.

3. Interview Guide Questions

The semi-structured interview was used to gather in-depth information on students' personal experiences with the Project-based lessons. The interview guide consisted of six open-ended questions that allowed the researcher to probe deeper into students' reflections on the lessons, challenges they faced, and how the lessons helped them understand the concept of biodiversity. The interview was conducted in Tagalog to ensure that the students could easily articulate their responses.

4. Focus Group Discussion (FGD) Guide Questions

Two focus groups were formed. The first group consisted of 10 students per subgroup, and the second group comprised 10 teacher assessors. The purpose of the FGDs was to capture collective insights on the effectiveness of the Project-based lessons and to identify common themes regarding students' learning experiences. The student FGD was guided by questions that aimed to explore their engagement with the lessons, while the teacher FGD focused on evaluating students' learning outcomes, such as their 21st-century skills, understanding of biodiversity, and exhibited values and attitudes.

5. Scientific Values and Attitudes Checklist

This checklist was used to assess the development of scientific values and attitudes among students during the Project-based lessons. It included a set of core values derived from the Science curriculum, which helped the researcher measure the extent to which these values were fostered through the lessons.

6. Student's Lesson Log and Exit Ticket

The Student's Log and Exit Ticket were designed to assess students' understanding of the content after each lesson. The Exit Ticket contained six questions related to the lesson on biodiversity, prompting students to reflect on the key concepts they learned and how they applied them in the project. The Lesson Log also helped track their progress and provided insights into their

self assessment of the learning experience.

7. 21st Century Skills Rubrics

This rubric was used to evaluate the students' project outputs based on their demonstration of 21st-century skills such as critical thinking, collaboration, creativity, and communication. The rubric was adapted from the Buck Institute for Education, with modifications to ensure its relevance to the learning objectives of the study. The rubrics were validated by experts and provided a standardized way to assess the students' performance on the projects.

3. RESULTS AND DISCUSSIONS

This study aimed to develop project-based lessons focused on Biodiversity, evaluating their effectiveness in fostering student engagement and learning. The lessons addressed key features: student-centeredness, contextualization, collaboration, and differentiated tasks. These lessons were designed to cultivate critical thinking, communication, collaboration, and creativity among students, and assess their development in both content knowledge and values/attitudes.

The study was grounded in Constructivist Theory, emphasizing that learners construct knowledge through active engagement, and Transactional Distance Theory, focusing on the importance of communication in remote learning environments. The four project based lessons covered: the concept of species, energy flow in ecosystems, biogeochemical cycles, and human impacts on the environment.

Key Findings:

1. Features of the Project-Based Lessons: o Student-Centered: The lessons encouraged active student involvement, allowing them to choose learning approaches and use technology to produce outputs. These lessons were engaging, fostering higher student participation and interest.
    - Contextualized: The lessons incorporated real-world examples, making the content relatable to the students' local environment and everyday experiences, such as local biodiversity and environmental issues.
    - Collaborative: Group work was a major feature of the lessons, promoting teamwork and role-based collaboration. Students worked together to complete tasks, enhancing their learning through shared efforts.
    - Differentiated Tasks: The lessons provided varied tasks, catering to students' individual abilities, encouraging autonomy and personalized learning approaches.
2. Outputs Demonstrating 21st Century Skills: o Critical Thinking: Outputs like biodiversity maps, species collages, and models of energy transfer demonstrated students' ability to analyze, synthesize, and evaluate information.
    - Communication: Students showcased communication skills through various outputs, such as species photo albums, explainer videos, and vlogs, integrating multimedia tools effectively.
    - Collaboration: Group projects such as the creation of energy transfer models and mini-documentaries showed students' ability to work together, organize tasks, and respect each other's contributions.
    - Creativity: Outputs such as models, vlogs, and collages were assessed for originality, value, and style, demonstrating students' creative abilities.
3. Effectiveness of the Lessons: o Content Knowledge: The lessons effectively deepened students' understanding of biodiversity. Students reported enjoying the project-based approach, which allowed them to learn the material actively and cooperatively.
    - Values and Attitudes: The lessons were successful in developing essential values such as openness, stewardship, accuracy, and accountability. Students also demonstrated improved attitudes, including perseverance, curiosity, responsibility, and critical thinking. Other positive attributes like cooperation, patience, and respect were also noted.

The developed project-based lessons align with the K-12 Science curriculum of the Department of Education (DepEd) and were modified to suit the current blended learning modality, which includes limited face-to-face sessions. These lessons incorporate a rotation approach to address the challenges of remote learning while ensuring that the content and performance standards are met. The lessons are designed with the understanding that effective science teaching must consider cognitive, affective, and psychomotor factors in learning. Additionally, the social learning aspect of students is taken into account due to the absence of face-to-face instruction. Each lesson is structured around specific learning competencies derived from DepEd's Most Essential Learning Competencies (MELC). The lessons are guided by essential, unit, and content questions that foster critical thinking and ensure alignment with the learning objectives.

The lessons focus on higher-level thinking skills and are student-centered, contextualized, and collaborative. They

encourage the development of 21st-century skills such as critical thinking, communication, collaboration, and creativity. The students will work on micro-outputs either individually or in groups, with opportunities for peer and teacher feedback.

Designed for rotational blended learning, the lessons include synchronous online sessions with the teacher as a facilitator and asynchronous activities accessed through a Facebook group. The students will collaborate digitally or in person (with limited faceto-face interactions), balancing individual tasks to promote self-reliance and group tasks to enhance social interaction and learning from peers.

The lessons also emphasize differentiated tasks, allowing students to choose their outputs based on their skills and resources, ensuring they can engage meaningfully with the material. The project-based format offers opportunities for students to interact socially and develop positive values, making the learning experience more relevant and engaging despite the challenges of remote learning during the pandemic.

Ultimately, the project-based lessons were designed to bridge the gap created by the lack of face-to-face instruction and foster student collaboration, critical thinking, and creativity while keeping the focus on meeting the learning standards.

Table 1. Outputs Created by the Students Demonstrating the 21st Century Skills

Lesson Number/Title	Critical thinking	Communication	Collaboration	Creativity
1: Concept of Species	Biodiversity map- The students were able to analyze and interpret the data that they have gathered to compute for the biodiversity index Species collage, Photo album, Visual organizer- the students were able to conceptualize and organize the species according to hierarchical level of organization	Species photo album, species collage, biodiversity map: The students communicated with each other their ideas and knowledge about the tasks. They were also able to present their outputs through digital presentation.	Species photo album, species collage, biodiversity map. The students worked together in creating the outputs. They have worked their part in individual tasks and at the same time helped each other in the group tasks in preparing the projects.	Species photo album, species collage- the students created photo albums and species collage using indigenous and/or recycled materials.
2: Energy Transfer	Energy transfer model (food web, food chain, energy pyramid, pyramid of numbers, pyramid of biomass model - the students were able to analyze the contributions of each organism in each trophic level. They were also able to explain the effects of more producers and less consumers and vice versa.	Energy transfer model (food web, food chain, energy pyramid, pyramid of numbers, pyramid of biomass model- the students presented through google meet their energy transfer model with accuracy.	Energy transfer model (food web, food chain, energy pyramid, pyramid of numbers, pyramid of biomass model- each group was able to contribute in creating their energy transfer model through helping each other.	Energy transfer models (food web, food chain, energy pyramid, pyramid of numbers, pyramid of biomass model-the energy transfer model were made using local, indigenous and recycled materials. The outputs also display student imagination in creating their outputs

3: Biogeochemical Cycles	Tigsik, rawit dawit, explainer video- the students were able to apply what they have learned about biogeochemical cycles in creating a tigsik or rawit-daw explaining the different biogeochemical processes and explain the connections of each cycle to each other.	Tigsik, rawit dawit, Explainer video-the students presented and explained thoroughly the processes involved in the different biogeochemical cycles	Explainer video – the students helped each other in listing the organisms and identifying the roles that they play in the biogeochemical cycle. They also helped each other in creating the video.	Explainer video – students were able to create a very engaging and artistic explainer videos
4: Human Impacts on the Environment	Open letter, Mini-documentary, Vlog,– the students were able to explain the impacts of the human activities to biodiversity and suggest ways on how they can contribute	Interview, Mini-documentary, Vlog – the students interviewed their neighbors, teacher, and barangay officials about the human impacts on the environment and the different threats to biodiversity. They were also able to create vlogs that convey the message of taking care of the environment.	Mini-documentary, Vlog – the students helped each other in creating the outputs.	Mini-documentary, Vlog – the students created a vlog in a very creative manner and presentation

4. CONCLUSION

Based on the findings of this study, the following conclusions were drawn:

1. Development and Validation of Project-Based Lessons: Four project-based lessons in teaching and learning biodiversity were successfully developed by the researcher. These lessons, which were aligned with the Most Essential Learning Competencies (MELC) as prescribed by the Department of Education (DepEd), were validated by experts in the field of science education and project-based learning. The developed lessons were designed with key pedagogical features, namely, being student-centered, contextualized, collaborative, and incorporating differentiated tasks. These features ensured that the lessons catered to diverse learning needs and encouraged active engagement, critical thinking, and cooperation among students.
2. Student Outputs Demonstrating 21st Century Learning Skills: The outputs produced by the students as a result of engaging with the project-based lessons effectively demonstrated various 21st-century learning skills, including critical thinking, communication, collaboration, and creativity. Notable outputs included species photo albums, biodiversity maps, species collages, energy transfer models, tigsik, rawit-dawit, explainer videos, open letters, mini-documentaries, vlogs, and tiktok videos. These outputs not only displayed the students' ability to think critically about biodiversity but also showcased their skills in communicating complex ideas, collaborating with peers, and employing creative approaches to express their learning.
3. Effectiveness of Project-Based Lessons in Enhancing Content Knowledge and Values: The developed project-based lessons were found to be highly effective in promoting students' content knowledge as well as their values and attitudes. The lessons facilitated students' ability to learn and construct their understanding of biodiversity through hands-on activities, peer interactions, and teacher guidance. Additionally, the project-based approach helped students develop important personal and social values, particularly patience, responsibility, and helpfulness, as they worked collaboratively on various tasks and shared knowledge with their peers.

Recommendations

Based on the conclusions drawn from this study, the following recommendations are proposed:

1. Development of Additional Project-Based Lessons in Science: It is recommended that more project-based lessons be developed in various areas of the science curriculum. These lessons should integrate the essential features identified in this study—student-centered, contextualized, collaborative, and differentiated tasks. By incorporating these elements into future lessons, educators can create learning environments that promote deeper engagement and understanding, while addressing the diverse learning needs of students.
2. Assessment of 21st Century Learning Skills: The outputs generated from project-based lessons should be evaluated to determine the extent to which they demonstrate 21st-century learning skills such as critical thinking, communication, collaboration, and creativity. Teachers and curriculum developers should continue to use rubrics and other assessment tools to ensure that the project-based approach fosters the development of these essential skills, preparing students for future challenges in the workplace and society.
3. Enhancing Content Knowledge and Values Through Project-Based Learning: Project-based lessons should be further utilized as a tool to positively influence both students' content knowledge and their personal values and attitudes. Teachers should recognize the potential of project-based learning to not only improve students' academic understanding of science but also to nurture qualities like cooperation, perseverance, responsibility, and critical thinking. These values are crucial in fostering well-rounded learners who are capable of addressing complex real-world issues.
4. Further Research and Improvement of Project-Based Lessons: Future studies should be conducted to further refine and improve the project-based lessons developed in this study. Research should focus on evaluating the long-term impact of these lessons on students' learning outcomes, as well as exploring how the lessons can be adapted for use in different educational contexts. With the researcher's consent, collaborative studies can be conducted to identify best practices for implementing and enhancing project-based learning in science education. Additionally, further investigations can assess the scalability of these lessons for use in other subjects or grade levels.

In conclusion, the findings and recommendations of this study suggest that project-based learning is a powerful pedagogical approach for teaching complex scientific concepts, such as biodiversity, while also fostering important life skills. The integration of project-based lessons into science education can significantly enhance both the academic and personal development of students, preparing them for success in the 21st century.

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