

Project-based learning of most essential learning competencies in biology

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Abstract

This study developed seven project-based learning activities for General Biology 1 most essential learning competencies for the most essential learning competencies in Biology with features of key knowledge, understanding, and success skills, challenging question, authenticity, reflection, and public product. These were subjected to jurors' evaluation in terms of Department of Education standards, alignment to most essential learning competencies, and presence of features. The study also determined the students' experiences during the process of accomplishing the project-based learning activities and the insights they derived from their learning experiences. This study utilized a descriptive developmental design. The respondents were the 62 Grade 11 STEM students of Tabaco National High School for the School Year 2020-2021. They belong to Digital Modular Distance Learning (DMDL) class. The jurors' assessment of the project-based learning activities obtained a passing rating on all the criteria indicated in LRMDs—content, format, presentation and organization, accuracy, and up-to-datedness of information. The jurors also gave a very highly evident rating on all the criteria—alignment to most essential learning competencies and presence of features, meaning the lessons met most of the expectations. Based on journal entries and observation sheets, students had positive and negative experiences in accomplishing the project-based learning activities which were observed in four stages: preliminary, planning, development, and presentation. They also shared insights that were derived from their learning experiences.

Keywords: project-based learning, most essential learning competencies, biology, distance learning

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1. Introduction

The COVID-19 pandemic has struck the world as a public health emergency. COVID-19 was first experienced in late December 2019 in Wuhan, China (Shereen et.al. 2020). The first coronavirus infection outside of China was recorded on January 13, 2020, and the World Health Organization took note of the outbreak that was spreading to different continents on February 02, 2020, according to the COVID-19 schedule. The first local transmission of COVID-19 was confirmed in the Philippines on March 7, 2020. The virus has spread across the country since then, with at least one case documented in each of the country's 17 provinces. COVID-19 patient prevalence has been connected to socioeconomic status across the country. Lockdowns, sometimes known as communal quarantines, have been observed.

The war against this life-threatening infection had far-reaching consequences and repercussions in practically every aspect of human society. Travel restrictions (Chinazzi et al., 2020), school closures (Viner et al., 2020), political conflicts (Barrios & Hochberg, 2020), racism (Habibi et al., 2020), global economic recession (Fernandes, 2020), and misinformation and controversies (Enitan et al., 2020), to name a few, have all resulted from these factors. The educational sector is one of the hardest hits. COVID-19 is still present today, and there are no specific vaccines or medications available to treat it. Denworth (2020) asserted that there is a need to adapt to a new normal; if the virus is not contained, it is a must to adapt to the disease, as viruses are always developing. Scientists, on the other hand, are still on their way to studying and developing vaccines and are presently in clinical trials (Cortegiani et al., 2020; Dong et al., 2020; Gautret et al., 2020).

Most countries have temporarily closed educational facilities to slow the spread of the COVID-19 pandemic and limit infections (UNESCO, 2020). This closure has impacted over 1.2 billion students globally, including over 28 million in the Philippines (UNESCO, 2020). Regardless of the circumstances, UNESCO emphasizes that learning must continue or human capital will dwindle. To address this issue, the Department of Education (DepEd) compiled a list of the most essential learning competencies (MELCs). This was one approach to implement SDG 4 (Quality Education) and the Sulong Edukalidad framework, which aspire to provide quality education to all Filipino learners in the twenty-first century.

Due to the limited face-to-face connection between teachers and students, DepEd identified essential learning competencies which have the same objective or intention, and learning competencies that are too specific, recurring, and subsumed in another learning competency are removed/dropped. All the learning competencies are rephrased to be more concise. The endurance indicator was used in the selection of the most essential learning competencies, indicating that the learning competencies are for lifetime learning. The idea is for it to stay with the students long after the unit has been completed. The content and performance requirements are still retained in the modifications and are taken directly from the 2016 curriculum guide. It simply means that the MELCs are based on the prescribed criteria and are not a divergence from the basic education curriculum that is based on standards.

In terms of teaching, DepEd released a list of learning delivery modalities for the school year 2020-2021 to ensure that learning is not hampered as the country fights the pandemic. One of these options is distance learning. Distance learning is a method of instruction or learning in which the teacher and the learner are separated geographically. Between the pupils and the teachers, there is no interaction. Modular Distance Learning (MDL), Online Distance Learning (ODL), and TV/Radio-Based Instruction are the three types of this modality. Students in distant education will be responsible for their learning. However, teachers must ensure that their students continue to study in a meaningful way. It is the responsibility of the teachers to assist students in developing the self-management abilities they will need to succeed in the distance learning setting.

Teachers find it difficult to keep their students engaged in and accountable for their learning through distance learning. The educational setting will always be at the root of the problem. Students will find it difficult and rather tedious to acquire things in a non- interactive manner, particularly in Biology classes. Biology is one of the subjects taught in high school science classes. It is the study of living things, which is separated into several sub-disciplines. Biology is an extremely useful subject to learn. Biology professors instruct students on important concepts in cell biology, genetics, medicine, and other related fields that are crucial for human life. However, there are some ideas in Biology that they will lose interest in because they are frequently taught in a transmissive manner, which make the subject more abstract in the eyes of the students, making it seem irrelevant (UNESCO, 2010).

According to Agaba (2013), information retention is directly related to achievement in Biology education. To achieve optimum success in Biology education, students must retain knowledge obtained during the teaching and learning process. The preservation of the mind is defined as retention. Effective educational strategies should be presented inside the classroom for knowledge to be retained. It has the potential to encourage and support active involvement among students. In comparison to the traditional approach, the constructivist approach has a positive impact on student achievement in Biology. Students must develop ideas based on their experiences and learning, which will be most effective if learners participate actively. As a result, teachers must create organic experiences that allow students to construct knowledge in a meaningful social context (Dewey, 1938).

In distance education, a genuine instructional method should be used, and students should reflect on real-world interconnections in science through authentic evaluations. Students should not have a passive approach to learning. Despite the lack of face-to-face interaction, they should create meaningful learning. Students should continue to progress academically in Biology by honing their critical thinking skills. To solve these difficulties, however, there is no one-size-fits-all plan or technique. Teachers require an innovative instructional method to overcome the country's educational crisis. Project-based learning (PBL), which has its roots in the progressive education movement of William Heard Kilpatrick and John Dewey, is a method in which students try to solve a problem that is based on a real-world difficulty. This method requires students to actively investigate and explore significant content while also learning skills that are critical to the inquiry process to answer the essential question that will lead to deeper learning through active exploration of real-world problems and challenges (Condliffe, 2016; Iwamoto et al., 2016; Harmer & Strokes, 2014; Holmes, 2012; Bell, 2010; Thomas, 2000; Katz & Chard, 1992).

Project-based learning (PBL) is an instructional framework that encourages students to work in groups to answer a central issue and complete a project. It allows teachers to bring learning to life for pupils. Students work on a project that engages them in addressing a real-world problem or answering a challenging question over a long period, ranging from a week to a semester. They show off their abilities and knowledge by creating a public product or presentation. PBL is one of the most recommended strategies/approaches to adopt during this period, as teachers navigate new obstacles on how to provide meaningful learning to their pupils. PBL has been proven to be an effective method of delivering teaching and assessment in numerous studies, and teachers continue to use it as an engaging model of learning to learn content and skills across the curriculum.

In this premise, the goal of this research was to construct project-based learning activities for most essential learning competencies in General Biology 1. The project-based learning activities were to be evaluated by some experts. Further, the study aimed to gather the learning experiences and insights of the students in accomplishing the activities. The respondents of this study would be the Grade 11 senior High School students in the Science, Technology, Engineering, and Mathematics (STEM) strand of Tabaco National High School.

Statement of the Problem - The study aimed to develop project-based learning activities for most essential learning competencies (MELCs) in Biology for Grade 11 Senior High School-(STEM) at Tabaco National High School. Specifically, the study sought to answer and discuss the following: 1. What project-based learning activities may be developed for the most essential learning competencies in Biology following the key features

such as key knowledge, understanding, and success skills; challenging question; authenticity; reflection; and public product? 2. What are the jurors' evaluations of the project-based learning activities in terms of the following Department of Education (DepEd) standards; alignment to Most Essential Learning Competencies' and presence of features? 3. What are the students' learning experiences during the process of accomplishing the project-based learning activities? 4. What insights were derived by the students from their learning experiences?

Significance of the Study - This study intended to explore and develop project-based learning in teaching the most essential learning competencies (MELCs) in Biology for distance learning. Specifically, what it sought to explore may be beneficial to schools, especially for continuing education in the new normal. In particular, the study is expected to benefit the following: **Students**. The use of the developed project-based learning activities would help the students achieve meaningful learning and enhance their skills as an effective approach to distance education. **Biology Teachers**. The teachers could directly utilize the project-based learning activities to teach the most essential learning competencies in STEM Biology. They could also gain ideas from this material to teach Biology constructively in face-to-face and distance education classes. **Educational Administrators**. The result of this study would serve as baseline data to design educational activities in schools which could be used to improve and promote meaningful learning in distance education. **Curriculum Designers**. This might serve as their additional source of information in designing new approaches for learners, especially in times when there is a public health emergency, where distance learning took place. **Future Researchers**. The findings or outputs of this study could be used by future researchers as inputs in their study.

2. Related Literature

The sector most affected by the COVID-19 pandemic is the education sector. Several educational institutions were closed. Education, however, must go on. The Department of Education offered many solutions to this problem. The Department of Education (DepEd) has compiled a list of the most important learning competencies (MELCs). For each quarter, they determined the most important learning skills. The DepEd's updated MELCs serve as the foundation for the distance learning program. MELCs, it was pointed out, are part of the Department of Education's reaction to establish a resilient education system, particularly during emergencies, and are set to be implemented in the 2020-2021 school year. According to the DepEd's recommendations, using MELCs will enable the Department to focus instruction on the most essential and vital competencies that the learners must acquire as it anticipates learning delivery issues. It will also make turning classroom-oriented learning resources into distance learning tools easier.

The release of the MELCs has no bearing on the standards established by the K to12 curriculum guides. Rather, they serve as teachers' guides as they address students' instructional needs while maintaining and achieving curriculum requirements. The most essential learning competencies were identified after a rigorous procedure. As part of its ongoing review of the intended curriculum, the Department of Education's Bureau of Curriculum Development- Curriculum Standards Development Division, in collaboration with the Assessment Curriculum and Technology Research Centre (ACTRC), began working on the identification of essential learning competencies in the middle of 2019. Bureau specialists, academic experts, and field implementers collaborated to develop a set of criteria for determining these competencies. The K to 12 Curriculum Review, spearheaded by Secretary Leonor Magtolis-Briones, is not only meant to fulfill one of the provisions of the Republic Act (RA) 105333, which requires a review of the curriculum, but it is also part of her commitment to ensuring quality, relevant and liberating education for all. The Secretary will convene the Curriculum Consultative Committee to deliver the conclusions once the four phases of curriculum review are finished, as called for in Section 6 of the same Republic Act.

The review focuses on articulation within and across learning areas to identify gaps, difficulties, and concerns across learning areas and grade levels. The review focuses on mapping essential and desirable learning competencies within the curriculum, identifying prerequisite knowledge and skills needed to prepare students for essential learning competencies, and analyzing how prerequisite knowledge and skills are interconnected among

the learning competencies of each subject area. Essential learning abilities are described as what children require in the teaching- learning process to develop skills that will prepare students for succeeding grade levels and, ultimately, for lifetime learning. On the other hand, desirable learning competencies were described as those that may benefit education but are not required to develop fundamental skills. Essential learning competency characteristics were supplied to assist reviewers in determining which learning competencies are most important. They are aligned with national and local standards/frameworks and they connect the content to higher concepts across content areas. In addition, they apply to real-life situations since students need to have this competency above many others even if they leave school, and it is not expected for most students to learn this in settings other than formal education.

These characteristics are based on a competency validation rubric developed in the United States with some adaptations for the Philippine context. The Bureau of Curriculum Development hastened the identification of essential learning competencies. It simplified them further into the Most Essential Learning Competencies (MELCs) in response to the challenges provided by COVID-19 in terms of learning delivery. Tom W. Many and Ted Horrell wrote an essay titled "Prioritizing the Standards Using R.E.A.L Criteria," describing the criteria for picking vital standards. Horrell and his colleagues in Shelby County, Tennessee, have turned Reeves and Ainsworth's criteria into an easy-to-remember acronym. Teachers discuss whether a certain criterion should be prioritized using the R.E.A.L criteria (Readiness, Endurance, Assessed, and Leverage). The readiness standard equips students with the necessary information and abilities to succeed in the following class, course, or grade level. Students who complete the 'Endurance' standard gain information and abilities that will benefit them beyond a single test or course of study. In upcoming state and national tests, the assessed standard will be evaluated. Finally, the leveraging standard will equip students with information and abilities that will be useful in various fields.

The Department of Education deemed the descriptor "endurance" the key determining element in creating the criteria for selecting the most necessary learning qualities. A learning competency is considered enduring if it remains with learners long after a test or unit of study is completed or is useful beyond a single test or unit of study. Examples of such learning competencies include research skills, reading comprehension, writing, map reading, and hypothesis testing, which are essential in many professions and everyday life (Reeves, 2002; Many & Horrell, 2014). Choosing whether to keep, merge, drop, or rename a learning skill was a part of the process. A learning competency was preserved as a general rule if it met the endurance criterion, which strongly adds to life-long learning and is a prerequisite skill for the following grade level. If two or more learning competencies have the same aim or learning intention, they are integrated or clustered into one comprehensive learning competency. They are too particular, and the articulation is comparable to that of a learning objective; they are regarded as appropriate to be introduced in an earlier quarter or grade level. In addition, some competencies were rewritten to be more concise.

The content and performance criteria, on the other hand, are taken straight from the curriculum guides. This is to emphasize that the identification of MELCs is anchored on the prescribed standards and not a departure from the standards-based basic education curriculum. Learners at all grade levels will continue engaging in all learning areas but with streamlined competencies to fit the diverse contexts of learners, teachers, learning environments, and support systems, considering content and performance standards. Students benefit from learning the ideas and skills in the MELCs through meaningful activities and scenarios that are relevant to them and take place in the student surroundings. MELCs can be used as long as the intended activities also teach the procedures and methods for applying such knowledge and abilities in a specific situation. Despite the current health crisis, learners may expect relevant and high-quality basic education with these. Thus, despite the usage of distance learning, schools must adhere to the MELCs to continue producing complete Filipino learners with 21st-century abilities. Distance learning is one of DepEd's recommended 2020-2021 school year learning modes.

Learners use a computer, tablet, PC, or smartphone to access electronic copies of learning materials. E-learning resources, including offline e-books, can be delivered via CDs, DVDs, USB storage, and

computer-based apps. The teacher is responsible for keeping track of the student's progress. The learners may ask for assistance from the teacher via email, telephone, text message/instant messaging. That is one of the possible solutions to the current educational crisis.

During these unprecedented times and school closures, how the teachers can keep students connected and engaged, and how they will achieve and ensure meaningful distance learning, specifically in Biology, is a serious concern. Biology is a course or subject requiring students' exposure to different learning experiences to develop conceptual understanding. The diversity of biology concepts will be more retained in students' minds if they consider personal experiences of what they have observed and learned. One of the learning experiences is to help the students work independently and on hands-on activities depending on the content, values, and skills that need to be carried out, which can help them achieve meaningful learning. Project-based learning (PBL) can help with this. It increases students' enthusiasm for science and their comprehension of scientific concepts (Langbeheim, 2015). It entails using "real-world" situations as a setting for students to develop critical thinking and problem-solving abilities and knowledge of the subject's core principles. Knowing and doing come together in project-based learning when students apply what they have learned to address real-world challenges to produce meaningful outcomes.

Project-based learning is also particularly suitable for distance learning involving acquiring and developing knowledge and skills. Larmer (2020) discusses why project-based learning works well for remote learning in his paper "Project-based learning can make remote learning more meaningful." Projects that are authentic to real-world concerns and relevant to students' lives, he believes, are intrinsically motivating. Traditional assignments and classes offered online are less likely to keep students engaged than engaging in projects. In PBL, the teacher does not control everything in the classroom; the culture emphasizes independent student work time, collaboration with a team, and inquiry guided by students' questions. This translates well to at-home learning, where the teacher (much less a parent or a caregiver who needs to work) cannot observe and guide students as frequently as in a brick- and-mortar classroom. A relationship with audiences, experts, and organizations outside of the classroom is one of the most essential parts of authenticity in PBL. Students working on projects from home, who are already working online and using digital tools for communication and collaboration, find it easier and more natural to connect than students in typical classroom settings.

Teachers employ a variety of technology tools to manage PBL online. Teachers use some technology tools to help manage PBL online. It can be done with WebEx, Google Meet, Zoom, and Whereby for individual and group meetings. For whiteboards and brainstorming, Mural and Explain Everything are virtual boards that can be used for targeted instruction and are fantastic for remote brainstorming and problem ideation. For student project management, Trello is an example of a tool that can help students keep track of project action items and then share them with their project teams - a valuable skill students need to master regardless of context. For customized online instruction, Nearpod can be used to create customized online instruction that targets the individual needs of each student.

Some PBL strategies can be implemented if students do not have access to technology or the internet. Providing engaging, hands-on activities that contribute to bigger project goals, such as data collection or participating in a daily "go outdoors" mindfulness observation practice—instructing students to create prototypes for project products using whatever resources they have on hand are a few examples. Rather than creating digital products or online presentations, they can develop suggestions for solutions to problems. To obtain additional expertise and feedback for prototyping or proposal writing, have students interview family members and neighbors or call faraway people. Use art, cooking, building, construction, and the outdoors as resources. Ask pupils to perform an individual project in which they choose a topic of interest, investigate it independently (for example, family history, baseball or skateboarding physics, and cookery science), and produce a written output or use a mobile phone to generate films.

In the field of education, PBL is not a new concept. It has been used in a range of content areas and a variety

of situations for decades. Long-term, multidisciplinary, and student-centered project-based learning activities are interwoven with real-world concerns and problem-solving. This strategy encourages exploring and resolving complicated challenges through abstract tasks (Condliffe, 2016; Iwamoto et al., 2016; Harmer & Strokes, 2014; Holmes, 2012; Belle, 2010; Thomas, 2000; Katz & Chard, 1992). Project-based learning promotes understanding the underlying concepts rather than just practicing rote memory skills. It employs projects to motivate students and create opportunities for them to demonstrate and explain what they have learned. Furthermore, it allows students to investigate, make judgments, analyze, and synthesize data in meaningful and innovative ways.

Ravitz et al. (2012) defined 21st-century skills as productivity and accountability, social and cross-cultural skills, creativity and innovation, critical thinking and problem-solving, communication and collaboration, information, communication, and technology literacy, flexibility and adaptability, initiative and self-direction, and leadership and responsibility. Project-based learning encourages students to learn via demonstrations of performance in which they will use the knowledge and skills they have gained. Additionally, in recent literature, the benefits of PBL are emphasized, namely increased academic achievement, increased application and retention of information, critical thinking, communication, and collaboration (Condliffe, 2016; Iwamoto et al., 2016; Harmer & Strokes, 2014; Holmes, 2012; Belle, 2010; Thomas, 2000; Katz & Chard, 1992).

In a PBL project, there are specific requirements to examine. The five characteristics of a PBL project are stated by Thomas (2000) in his essay "A review of research on project-based learning." Project-based learning projects are central to the curriculum rather than peripheral to it. Thomas's (2000) comprehensive analysis of the project-based learning approach became the most quoted piece on PBL research after its publication. According to Bell (2010), PBL is an innovative teaching technique that tackles a wide range of abilities necessary for 21st-century success. Harmer and Strokes (2014) looked at the advantages and disadvantages of project-based learning. The main advantages of PBL, according to them, include improved academic results, the development of broader skills, increased student motivation and enjoyment, student learning through revision, enhanced outreach and engagement beyond academia, and advantages for lectures.

Harmer and Strokes (2014) also outlined some of the predominant challenges of the PBL raised in the literature. Some significant identified challenges across the discipline are group work, preference for traditional teaching styles, assessment, and weight of work for students and teachers, and administrators. The authors suggest that proper planning and scaffolding are two approaches to avoiding these problems. Condliffe (2016) conducted a comprehensive review of project-based learning in K-12 classrooms, focusing on how students develop new skills and knowledge. PBL promotes knowledge construction, cultivates student engagement, uses scaffolds to guide student learning, encourages student choice, and supports collaborative learning. Students are expected to demonstrate their learning by creating a product that answers the essential question, provides student reflection and teacher feedback opportunities, and presents the product to authentic public audiences.

Understanding the fundamental principles and features of project-based learning before incorporating it into teaching is essential. The Buck Institute for Education (BIE) is a non-profit organization that assists teachers in using PBL efficiently. It has conducted considerable project-based learning research. In addition, the BIE has created curriculums, curriculum additions, tools, and several articles and videos about using and implementing project-based learning. According to the BIE, there are several essential elements of project design, the basis for project-based learning. The elements were used in this study which are as follows: First, the key knowledge, understanding, and success skills. A project should be focused on student learning goals. It should also include standards-based content and skills. These skills include critical thinking, collaboration, and self-management.

The second is the challenging problem or question. The challenge level of the problem or question should be appropriate for the student(s) working to solve it. The problem or question should also be meaningful to the students(s). It is the most crucial part of the PBL since this will start the project. Another one is authenticity. Since PBL promotes meaningful learning, authenticity is required. It means that the assessment taken out by the students are real-life situations. A project can be considered authentic following the criteria: it addresses real-life

problems, real people use the produced outputs, the topic is directly relevant to students' lives, the simulation seems realistic, and the process and tools used are basic things adults use.

The next one is reflection. It is essential in PBL. This is because students become aware of their responsibilities inside the classroom. The students also realize the purpose of learning when they reflect. This mirrors why they need to study. In a more profound aspect, professionals like researchers and scientists often reflect on how effective their strategies are and the obstacles they encounter. These are the things they consider in doing their work well. Just like them, students should develop reflective practices where realizations come in for them to develop lifelong learning skills. The last feature is the public product. This makes PBL different from traditional education since products are publicly presented. This sets the student's minds that they need to do a higher quality of work. In distance learning, public products can still be done with the help of various applications. Science teachers can allocate time for each student who will present their work. They can also maximize the use of having open discussions and exchanging thoughts. Lastly, PBL with public products is transformative for students since they are the pitch-makers of ideas, products, and performances.

Project-based learning will give the students opportunities to engage in real-world problems and tasks that will help them better understand certain concepts and competencies in Biology. The development of project-based learning activities in teaching the most essential learning competencies in Biology is the primary concern of this study, which aims to help students learn better as they engage in distance learning as a response to the existent COVID-19 pandemic.

2.1 Related Studies

Several studies which have relevance to the present study were reviewed and discussed below. The researcher found studies that discuss the concepts of project-based learning and its advantages. There were studies reviewed showing that PBL can promote student learning and skills development. Students become more robust problem solvers, researchers, and critical thinkers as a result of PBL, according to studies (Bell, 2010; Thomas, 2000; Condliffe, 2016). Students who work in a PBL class are more likely to succeed than in a standard classroom (Bell, 2010; Thomas, 2000; Condliffe, 2016). PBL's effectiveness in different subject areas as well as deepening students' transfer skills, has been investigated in various studies (Condliffe, 2016; Iwamoto et al., 2016; Chiang & Lee, 2016; Mayer, 2016; Cervantes et al., 2015; Khaliq et al., 2015; Harmer & Strokes, 2014; Redmond, 2014; Holmes, 2012; Bell, 2010; Yancin et al., 2009). PBL students develop analytic skills as well as a real-world application of information and skills (Katz & Chard, 1992).

Rubrica (2018) embarked on action research on project-based learning and knowledge by design and their influence on scientific student outcomes and attitudes. This study aimed to see how project-based learning, utilizing the Understanding by Design framework, affects students' academic progress and attitudes in science 6. The investigation was conducted at Quiteria Elementary School in Caloocan City. Group A (Gold) was taught using a project-based learning method, while Group B (Garnet) was taught using a traditional method. Both groups were given a pretest and a posttest to see if there was a statistical difference in their performance. Because of the statistical difference, PBL has been demonstrated to be a more successful approach to teaching science. Research on the effect of project-based learning is favorable in both the achievement and affective domains. Two sets of teachers, two from the high SES and four from the low SES, and a subset of their students participated in a study by Halvorsen et al. (2014) to see if there was a significant difference in academic achievement in social studies and content literacy between the two groups. The data were quantitative and qualitative, and the researchers employed a formative experiment approach. The participants represented two separate school districts. The study's findings revealed that students from low socioeconomic backgrounds scored statistically the same as students from high socioeconomic backgrounds. Teachers who used the project-based approach became more concerned about their students' 'comprehension' of the subjects.

Chiang and Lee (2016) looked at the impact of project-based learning on vocational high school students in

eastern Taiwan in their motivation and problem-solving abilities. The treatment group had 46 students, while the control group had 42 students who majored in food and drinks. The treatment group received project-based instruction during the four weeks, whereas the control group received traditional instruction. Both groups were given questionnaires that included learning motivation scores and problem-solving ability. Results showed that the project-based learning method positively affected the students' learning motivation and problem-solving abilities. Mayer (2016) explored students' perspectives on life skill development in project-based learning schools. According to the findings, students' perceptions of time management, teamwork, communication, and self-directedness improved dramatically. The use of a project-based learning approach increased students' perceptions of their life skills, according to the study.

Cervantes et al. (2015) looked at the effects of project-based learning on student achievement in mathematics and reading. The researchers conducted a casual-comparative study to compare the achievement of grade seven and eight students in two schools in a district in south Texas, USA, during the 2011-2012 school year. The researchers utilized experimental and control groups, with the experimental group using PBL as a teaching method and the control group using a traditional approach. The State of Texas Assessments of Academic Readiness (STARR) was used to assess the learning program's outcome. The study found that respondents who participated in the PBL program scored much higher on the STARR than those taught using a more traditional approach to instruction.

Khaliq and colleagues (2015) looked into the effectiveness of project-based learning in teaching science to elementary school students. As a sample school, one of the federal government's high schools was chosen at random. Then one section of the grade 8 class was randomly selected to participate in the study. Project-based learning was used to teach a chapter on the environment. A pretest and a posttest in the field of science were designed to assess the student's academic achievement before and after the experiment. As a result, findings revealed that the students who received the treatment outperformed the control group. Project-based learning has been proven to be a more successful teaching method in science since it encourages students to explore their innate curiosity. A project calendar and rubric were issued to keep the students focused on completing the intended assignment. The researchers recommended using PBL in the classroom, mainly in science subjects.

According to a study by Redmond (2014), project-based learning enhances students' academic attainment through cooperation, active engagement, and meaningful projects. The study's primary focus is an academic accomplishment, which led to data collecting around the research question, "How does project-based learning affect student achievement?" Redmond (2014) employed two fourth-grade science parts. There was a treatment period and a non-treatment phase for each part. The Northwest Evaluation Association Measures of Academic Progress NWEA MAP test was utilized to obtain the score used in the statistical analysis. The statistical analysis found that following a treatment phase, pupils scored much higher on the test than those who did not receive treatment. Redmond's (2014) research is quite helpful in discovering the key to how teachers may improve project-based learning in the classroom. According to him, it is imperative for teachers to develop a plan and execute project-based learning at the beginning of the academic year and to make it a part of a classroom routine that students are familiar with. In that way, the process of collaboration and research will become spontaneous for the students.

Kortam et al. (n.d.) conducted a study to see how PBL influences the attitudes and motivation of middle school biology students in Israel's Arab sector to learn biology. The study included 178 7th-grade students from six biology classes in northern Israel. The two-month study used a mixed methods research approach, which included both quantitative (questionnaires) and qualitative (interviews) (a semi-structured interview with the students). According to the study's findings, an intervention combining biology instruction with PBL results in greater student engagement and positive attitudes about biology studies. When PBL was employed, students reported more pleasure, curiosity, interest, and cooperation. The data imply that incorporating PBL into the classroom can increase students' motivation and attitudes. Cakici and Turkmen (2013) researched the impact of a project-based approach on children's science achievement and attitudes in a primary school in Northwestern

Turkey.

The study comprised 44 fifth-grade students in the quasi-experimental research design control group. The researchers observed all students creating their projects using the project-based learning technique. They provided scaffolding for the students' efforts by providing clues and encouraging them to be more imaginative in their projects. The results of the study show a significant difference in terms of achievement in science as a result of making learning more enjoyable and meaningful. However, there were no significant differences in the attitude towards science. The researchers inferred that the reason is the difficulties the students experienced during the project-making activities. Project-based learning is relatively new to the students, and scaffolding and gradual implantation of the approach were some of the recommendations given by the researchers.

Project-based learning effectively boosts students' academic achievement and enhances their attitude and willingness to learn. Yancin et al. (2009) investigated the effect of project-based learning on first-year science undergraduates' attitudes toward physics, electricity achievement, and the development of scientific process skills. The participants were 90 first-year science undergraduate students from Turkey's Bayburt Education Faculty's Science Teacher Training Department. Both the experimental and control groups were given pre-and posttests. The experimental group received project-based learning for the electricity unit, while the control group received a more traditional teacher-centered approach. The experimental group's achievement scores in the unit regarding electricity were statistically considerably higher than the control group. It was also discovered that the experimental group scored higher than the control group regarding scientific process skills and attitude. The researchers interviewed five students from the experimental group and asked them questions about what they thought contributed to their superior posttest scores. The interview highlighted that, with the support of the driving question at the beginning of the course, students gained confidence in their learning and the initiative to discover the knowledge and abilities needed to complete the project. Because project-based learning was new to them, difficulties such as time on task, division of work, and getting finances for the project were common among the interviewees.

Hernandez-Ramoz and De La Paz (2009) conducted another study on the effects of project-based learning on academic attainment. A total of 70 students from a Northern California district took part in the study. The students were split into two groups: control and experimental. The experimental group will be given a technology-assisted project-based approach in a six-week history unit on early nineteenth-century America. To establish the relative benefits of the program to the students, the researchers looked at topic knowledge tests, group projects, and an attitudes and views survey. Compared to a control group that received a more traditional teaching and learning program, the program outcomes significantly increased students in the PBL. The students' work in the intervention improved their historical thinking skills, and they could grasp the basic notion that history is more than just presenting and memorizing information. The related studies mentioned above educate the researcher on how to apply or integrate project-based learning. Since they primarily dealt with the benefits of PBL, they also gave a clearer view of how it will aid in obtaining meaningful learning.

2.2 Gap Bridged by the Study

This study focused on project-based learning that will be used in teaching biology's most essential learning competencies. In the reviewed related literature and studies mentioned above, there were only limited entries about the most essential learning competencies since this new educational concept was only introduced in 2020. However, there are numerous studies about project-based learning. These mainly dealt with its effects on the students' academic achievement, development of 21st-century skills, and change in attitudes. The research found no current study which links the teaching of the most essential learning competencies and project-based learning as well as distance learning. Distance learning is a learning modality suggested by the Department of Education in response to the COVID-19 pandemic. Furthermore, studies still need to develop project-based learning activities to be implemented in distance education. Also, the study aimed to capture the students' experiences in every phase or feature of the approach that was introduced, which is project-based learning. Developing

project-based learning activities in teaching the most essential learning competencies in biology for distance learning was the primary concern of the present study, which was very timely and had no similarity with an existing study during the time this research was conducted.

2.3 Theoretical Framework

Many theorists are credited with the development of project-based learning. The most credible were Dewey, Kolb, Bruner, and Piaget. The main theories embedded throughout are John Dewey's Active Learning Model and Kolb's Experiential Learning, Bruner's Discovery Learning, and Piaget's Theory of Constructivism that all played a significant role in the development of the aforesaid approach. John Dewey is widely regarded as the father of project-based learning. PBL emerged in the early 1900s when John Dewey and his advocacy of "learning by doing" reflected the theory of constructivism. Learning, according to Dewey, is an active, constructive process that demands practice rather than passive absorption. Project-based learning incorporates hands-on assignments that students in actual real-world scenarios supplement. He believed that students should be able to participate in their education. He believed that students would prosper in circumstances that allowed them to connect with the curriculum and learn via experiences (Talebi, 2015).

The foundation of Experiential Learning Theory is that learning is a process. Through this process, experiences derive, transform, and influence different notions (Kolb, 1984). Many scholars have done work with experiential learning theory. Experiential Learning Theory states that knowledge is created through grasping and transforming experiences. Its model is divided into four sections, two concerned with grasping experience and the other two with altering experience. The four components are substantial experience, abstract conception, reflective observation, and active exploration. The Cycle of Experiential Learning refers to the four components taken together. Concrete experiences serve as building blocks for observation and reflection throughout the cycle. This reflection is used to create abstract thoughts that can be utilized as a starting point for experimentation. This experimentation provides new experiences to draw upon (Kolb, 2008).

Discovery Learning was introduced by Jerome Bruner and is a method of inquiry- based instruction. This popular approach encourages students to build on their prior experiences and knowledge, apply their intuition, imagination, and creativity, and explore for new information to find facts, correlations, and new truths. Learning does not equal absorbing what was said or read but actively seeking answers and solutions. Project-based learning is also linked to Jean Piaget's Constructivism Theory. Piaget promoted a method of learning that should have emphasized memorizing. According to his thesis, project-based learning is a strategy that encourages pupils to invent and regard learning as a process with a future rather than a one-time acquisition of knowledge.

Figure 1 represents the paradigm of the theoretical framework of the study. It shows the connection among the various theories and the present study and how they serve as the basis for supporting this research. The paradigm shows that effective learning is guided by active, experiential, and discovery learning. In this study, the researcher developed project-based learning activities following crucial features that can teach students effectively. The activities developed were anchored on the theories mentioned above.

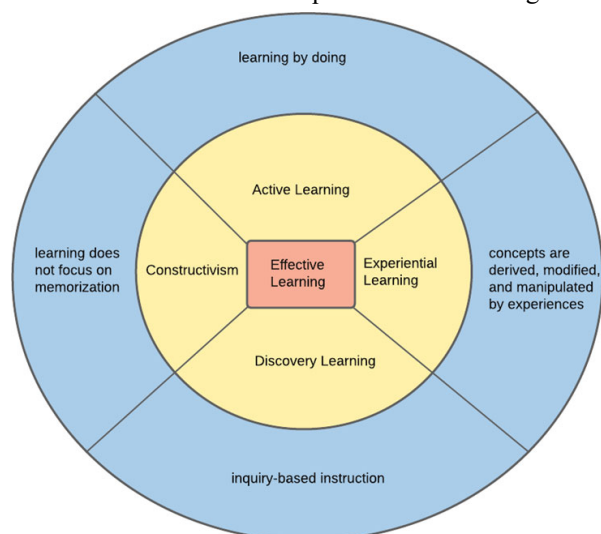


Figure 1. Theoretical Paradigm

2.4 Conceptual Framework

In response to the COVID-19 pandemic and to continue education, the DepEd curated the Most Essential Learning Competencies and suggested learning modalities, particularly distance learning. Project-based learning is one of the approaches that can help achieve meaningful and practical learning in distance education. Students will be given opportunities to engage in real-world problems and participate in an active learning process. Project-based learning helps students develop skills and acquire knowledge of the essential concepts of the subjects. Figure 2 depicts the study's conceptual framework. As shown, project-based learning activities will be developed and used to teach the most essential learning competencies in biology, following the key features such as key knowledge, understanding, success skills, challenging problem or questions, authenticity/authentic task, reflection, and public product. A group of experts will evaluate these activities in terms of the DepEd standards, their alignment with the most essential learning competencies, and the presence of features of project-based learning. The students will be asked to share their experiences in accomplishing the activities. Moreover, the study aims to get the insights derived by the students from their learning experiences.

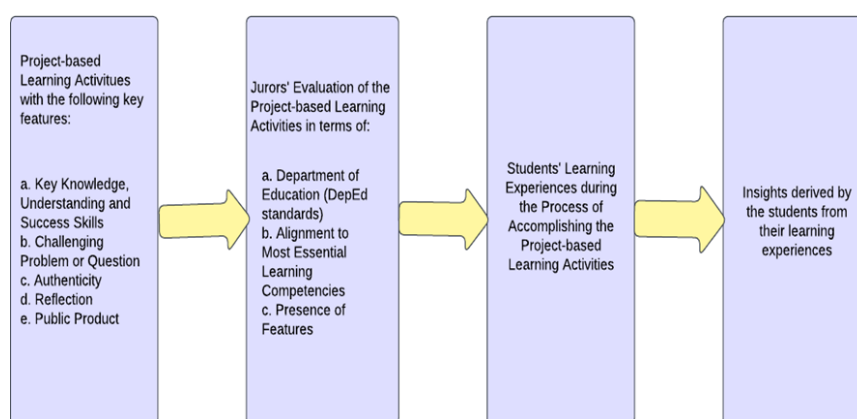


Figure 2. Conceptual Paradigm

3. Research Method

This study used the descriptive-developmental method. According to Gillaco (2014), the descriptive method looks for the facts regarding a specific situation. Also, this method focuses primarily on describing, comparing, analyzing, and interpreting existing data. Descriptive research is a method of research that seeks and describes something, such as the status, condition, or experience of a subject. Developmental research has been characterized as the systematic study of designing, developing, and assessing instructional programs, procedures, and products. Developmental research also focuses more on the effects of the product on the learner. It is essential in the field of instructional materials in teaching. The most typical type of developmental research includes examining, documenting, and assessing the product creation process. The descriptive-developmental method systematically studies the design, production, and careful evaluation of educational processes, products, and programs that must adhere to specific standards or requirements (Richey & Klein, 2005).

This study is descriptive because it described how the project-based learning activities for most essential learning competencies in General Biology 1 were developed. It explained the key features considered in making the activities. It also analyzed and discussed the jurors' evaluation in terms of DepEd standards, alignment to most essential learning competencies, and presence of features. Identifying the main themes in data from user studies such as interviews, focus groups, diary studies, and field studies is often done through thematic analysis (Rosala, 2019). This study employed thematic analysis of the students' learning experiences and insights into accomplishing the project-based learning activities. It is a method used for analyzing the qualitative data particularly the responses of the students and teacher-observers that involves reading and looking for patterns in the meaning of the data to find themes.

It is also developmental because a product is developed as instructional learning material. Five (5) activities

were developed for every most essential learning competency. Each activity had features of key knowledge, understanding, and success skills, challenging question, authenticity, reflection, and public product. Ten jurors evaluated the project-based learning activities in terms of DepEd standards, alignment to most essential learning competencies, and presence of features. They validated the activities on their content, format, presentation and organization, accuracy, and up-to-datedness, as part of the DepEd standards. They also assessed if the activities were aligned with the most essential learning competencies and if the presence of features was discernible. The ratings, as well as the comments and suggestions of the jurors, were used to improve the activities. The students were also provided with a journal entry guide containing questions. Teacher-observers were also given observation checklist. It contained questions and served as an instrument that sought to determine the student's learning experiences and insights in accomplishing the developed learning activities.

Sources of Data - The researcher employed a variety of sources to gather data to answer the problems of the study. The project-based learning activities were developed using secondary data sources. The K to 12 Curriculum Guide for General Biology 1 was used to identify the content and performance standard and, most importantly, the most essential learning competencies. Additionally, teacher's guide, self-learning modules, and Biology textbooks were utilized in making the content of the activity sheets. Articles, educational publications, and related studies about key features of good project-based learning activities were also used during the development of the said material. Jurors evaluated the developed project-based learning activities. The jurors used an evaluation rating sheet for print resources adopted from the Learning Resources Management and Development System (LRMDS) to assess the activities regarding DepEd standards. A developed evaluation tool for alignment to most essential learning competencies and the presence of features were also utilized. The rating, as well as the comments and suggestions of the jurors, served as one of the primary data sources. The evaluations were used to improve the learning activities that the students will utilize. Journal entry sheets were provided to students. They answered their journal after finishing the activity. Their responses, together with the observations of teacher-observers, served as the primary source of data in knowing their experiences and insights in accomplishing the project-based learning activities.

Respondents - The respondents of the study were the jurors who evaluated the developed material, the Digital Modular Distance Learning (DMDL) Senior High School STEM 11 students of Tabaco National High School, and the teacher-observers. They were selected according to their qualifications suited to answering the problems of the study.

Jurors. Jurors must evaluate the developed project-based learning activities before the actual implementation of the study. Several qualifications were considered for selection, such as educational degree, experience, and the subject they are teaching. The jurors must be Master's Degree holders in Biology Education; they should have more than three (3) years of teaching experience with a subject in Biology. The quota sampling method was utilized in selecting the jurors. The first ten qualified jurors were chosen to validate the developed material. The jurors comprised nine (9) females and one (1) male. The six (6) jurors belong to the age group of 26-30, while the other four (4) belong to 35-40. They are all graduates of MA in Biology Education, have more than five (5) years of teaching experience, and teach Biology in their respective secondary schools.

STEM Students. Aside from the jurors, the other participants in this study were an entire class of 62 Tabaco National High School Digital Modular Distance Learning (DMDL) STEM 11 students enrolled for the 2020-2021 school year. There are 29 females and 33 males. Their age group is 17-18 years old. They were selected through the convenient sampling method. These students were the ones who could attend in an asynchronous mode of learning. They have the internet and can access online learning materials. They were given the developed materials, observed, and asked to share their experiences accomplishing the activities.

Instruments - The study aimed to develop and utilize project-based learning activities for the most essential learning competencies in General Biology 1 and to obtain the student's learning experiences and insights. This study employed the following instruments to gather the needed data:

Juror's Assessment Tool. An evaluation rating sheet for print resources from DepEd's Learning Resources Management and Development System (LRMDS) was used to evaluate the developed project-based learning activities based on DepEd standards. The activities were assessed according to their content, format, presentation and organization, and accuracy and up-to-datedness of information. The activities must obtain at least 21 points out of a maximum 28 points to pass content validity. For format validity, it must score at least 54 points out of 72 points to pass. Also, the material must obtain at least 15 points out of a maximum 20 points to pass validity on presentation and organization. Likewise, accuracy and up-to-datedness of information requires a score of 24 out of 24 points to pass.

In addition, a different evaluation sheet was used to determine the congruency of the activities developed with the most essential learning competencies and the presence of the features. The evaluation instrument was modified based on the criteria of good project-based learning by the Buck Institute of Education. The first part of the evaluation tool required the jurors to write their personal data such as name, designation, field of expertise, school where he/she is employed, years in service, subject taught, and educational attainment. The second part of the tool obtained data on their evaluation of the alignment to most essential learning competencies and presence of features of the developed project-based learning activities. The indicators in the evaluation tool particularly in the presence of features were adopted from Buck Institute of Education which are key knowledge, understanding, and success skills, challenging problems or questions, authenticity, reflection, and public product. Before the tool was used by the jurors to rate the developed project-based learning activities, it was validated first by five (5) experts. They gave comments and suggestions on the indicators in the evaluation sheets. These validated evaluation sheets were given to the 10 jurors. Suggestions and comments were asked from them to serve as qualitative assessments of project-based learning activities in terms of alignment to MELCs and the presence of features. The capability of each feature was determined by summarizing the ratings given by the five experts.

Student's Journal Entry. One of the strategies used in gathering the students' experiences in accomplishing the project-based learning activities is journal writing. It is a standard method in qualitative research where participants use journals to refine ideas, beliefs, and their responses to the research in progress. Five (5) validators evaluated the journal entry guide. They commented on the questions to be included in the journal entry guide. In this study, the students should answer the journal entry individually in every activity. There were seven (7) activities so the students also submitted seven (7) journal entries. A template was made for a journal entry. It is composed of 10 questions. The students were asked to share their experiences while in the different stages of the activity: the preliminary stage, planning stage, development stage, and presentation stage. This flow of activity was adopted and modified from the design of Lee. They were also asked to write about the concepts they have learned in doing the project-based learning activities. Questions about exhibiting success skills such as critical thinking, collaboration, communication, and creativity and innovation were also asked to students. The journal also let the students describe the activities as to whether they are useful, difficult, challenging, or easy. The students were also required to share their negative and positive experiences in doing the activities. The students were free to choose their language to express their answers.

Observation Sheet. Another strategy used in gathering data is through teachers' observation sheets. It was a non-participant observation where the researcher/observer observed the activities but did not participate. Five (5) validators evaluated the observation checklist. They commented on the questions and indicators to be included in the checklist. In this study, there were three (3) Biology teachers who observed the students while accomplishing the project-based learning activities. It was done through direct observation, wherein the observers were included in the group chats of every group and were present during the video conferencing of the students. The students also sent videos when they were doing the activities. In this study, an observation sheet or checklist to be completed by observers was made. It includes the expected experiences of the students while doing the activities. They were also asked to identify the good points and areas for improvement.

Data Gathering Procedure - Asking for permission from the Schools Division Superintendent of Tabaco City and the Principal of Tabaco National High School was done before conducting the study on Digital Modular

Distance Learning (DMDL) class in STEM 11. The data-gathering procedure included the following phases:

Project-Based Learning Activities Development. Upon completing the proposal, the development of project-based learning activities was done. Different resources were used in preparation for making project-based learning activities. The K to 12 Curriculum Guide was a reference for the most essential learning competencies. Other materials also included learner's modules, teacher's guides, and biology textbooks. With reference to the third quarter of STEM General Biology, the most essential learning competencies considered were the following: describe the structure and function of major and subcellular organelles; distinguish prokaryotic and eukaryotic cells according to their distinguishing features; classify different cell types (of plant/animal tissues) and specify the functions of each; describe the stages of mitosis/meiosis given $2n=6$; explain the significance or applications of mitosis or meiosis; identify disorders and diseases that result from the malfunction of the cell during the cell cycle; and describe the structural components of the cell membrane according to their function.

The activity sheets considered and reflected key features of good project-based learning. These key features were the following: key knowledge, understanding, and success skills; challenging problems or questions; authenticity; reflection; and public product. There were seven project-based learning activities developed. They were designed as digital activity sheets since the students were under Digital Modular Distance Learning (DMDL). The first page of the activity sheets is the title and a cover photo of the PBL. On the second page is where the key knowledge, understanding, and success skills can be found. It includes the content standard and most essential learning competencies. The challenging question can also be found on this page. These are questions or problems that require the students to answer before doing the main task of the activity, which is on the third page. In this section, the students were instructed on the task or product they were expected to create. Extensive research was done to decide what task or project-based learning activity should be done by the students in every competency. This page also includes the duration of the activity. The students were guided by a timeline that showed the stages of accomplishing the activities and the day they should make it. Another section is the reflection. It is where the students will share their reflections on what and how they are learning through the activity. The fourth page comprises the public product section and reminders. In the public product section, the students are instructed to present their products on different online platforms. They were also reminded of the rules they had to follow strictly while performing the activities. On the last page is the scoring rubrics. It served as a guide for the students in making their products and presentation.

Development and Validation of Instruments to be Used. The instruments used in the study were developed such as the juror's evaluation tools, students' journal entries, and observation guides. The evaluation tools have the criteria for assessing the different aspects of project-based learning activities particularly alignment to most essential learning competencies and presence of features. The indicators in the features of project-based learning were adopted from the checklist of criteria prepared by the Buck Institute for Education (2019). Student's journal entry was also developed in order to get the learning experiences and insights of the students. The journal sheets were composed of 10 questions that the students needed to answer after doing the activities. Likewise, an observation checklist for teacher-observers was also developed. It included the expected experiences of the students that they had to check if they were able to observe them or not. After the development of these instruments, they underwent validation from five (5) jurors. The jurors are all MA Biology Education graduates. They assessed if the evaluation tools, journal entry, and observation checklist would help in gathering the needed data of the study. The validators gave their ratings on the instruments and comments and suggestions to further improve them before using them in actual implementation.

Validation of Developed Project-based Learning Activities. After the development of the activities, two evaluation tools were used to determine their validity— an evaluation rating sheet for print resources from DepEd's LRMDs and a developed evaluation tool for assessing alignment to MELCs and the presence of features. Ten jurors validated the learning activities. Each was given seven (7) printed copies of two (2) different evaluation tools for every project-based learning activity. First is the evaluation rating sheet of print resources

from DepEd's LRMDs. It validated the materials regarding DepEd standards on the content, format, presentation, organization, accuracy, and up-to- datedness. They examined the material and considered the extent to which the resource meets the criteria for each indicator or criterion. They also wrote comments and recommendations on the material not covered by the four (4) factors. Second is the evaluation tool on developed project-based learning activities in terms of alignment to the most essential learning competencies and presence of features. The jurors gave ratings and suggestions in each indicator for improving the activity. The researcher considered the suggestions and improved the activities before the actual implementation of the study.

Implementation. Once the PBL activities had been approved and refined, the study was implemented at Tabaco National High School. The researcher was given eight (8) weeks to conduct this study. During Day 1, a one-hour virtual orientation was conducted via Google Meet. Discussion included the purpose, key features, expected outputs, and further instructions on each part of the activity. During orientation, the rules or safety protocols amidst the pandemic especially prohibiting students from meeting each other were emphasized. A consent form was also secured from the students allowing the implementation of the study in the class.

After the orientation, the students were grouped into seven teams and created group chats in Messenger. Each team comprised eight (8) to nine (9) students. The group chats served as an avenue for the students to communicate and collaborate. The project-based learning activity was sent to every group chat as supplementary material to their self- learning modules every week. During the first week of implementation of the study, the first project-based learning activity, Visiting the Cell: Travel Brochure, was sent to the students. It was followed by the 3D Cell Model Making, Cell Types: Interactive Graphic Organizer, Mitosis and Meiosis: Student-built Model, Significance of Mitosis/Meiosis: Student-made Video Presentation, Diseases, and Disorders: Informative Flyers, and Cell Membrane: Student-made DEModel in the succeeding weeks. Students were given five days to finish the activity. They were guided by a timeline or duration of activity indicated in the activity sheets. They had one hour per day, as scheduled by their teacher, to do the tasks in their General Biology 1 subject. Every Monday became their Day 1 that also served as the preliminary and planning stage. As part of their planning, they were required to have a project-design plan when doing the activities guided by the template given to them. Day 2 to day 4 was the development stage and day 5 was their presentation stage. One of the essential features of an excellent project-based learning activity is that it should be a public product. Once the students finished the activity, they were required to present and share it with the class through group chats and Google Classroom. Further, it was rated using a scoring rubric. Other groups gave their comments and feedback. Then, video presentations were posted on a larger platform: YouTube. The students created a YouTube channel where they uploaded the video presentations they made.

After completing the activity, the students' journal sheets were sent to the group chats. The students answered the questions specified in the journal. They sent their entries to the Google Classroom so that secrecy and confidentiality would be observed. The observers also completed the observation sheets while the students performed the activities. When the students had their planning or meeting via online platforms, the teacher observers were there to monitor them. During the development stage, the students just sent video clips of them creating a product. The video clips were sent to Messenger group chats so the observers could watch them whenever possible. They wrote their observations, such as the good points and areas for improvement. The observation was conducted through online platforms. The students were asked to document their work through video calls or recorded videos.

Analysis of Data. The students successfully utilized the eight (8) developed project-based learning activities as supplementary materials for their self-leaning modules. After the implementation, students' responses taken from the journal entries and teacher observers' observations were analyzed qualitatively. This study employed thematic analysis for identifying, analyzing, and interpreting qualitative patterns. The responses of students and teacher-observers were read thoroughly. The researcher looked closely at the data to find common themes such as repeated ideas, topics, or ways of putting things. As the name implies, thematic analysis involves finding themes. A theme is a description of a belief, practice, need, or another phenomenon that is discovered from the

data (Rosala, 2019). The method used for conducting thematic analysis was journaling. The data are manually annotated and highlighted, and the researcher's ideas and procedures are then recorded.

There were several steps followed in conducting thematic analysis. The first step was gathering all the data—the responses of the students and teacher-observers, which served as the raw data collected. The second step read all the data from beginning to end. Since there were many respondents, reading all the data took a long time. Next is the coding of text based on what it was about. The researcher highlighted sections that needed to be categorized. They were coded and grouped according to the questions in journal entries and observation sheets. After coding, the researcher analyzed if there were similarities, differences, or contradictions among the data gathered. Because of the large volume of data, taking a break was also a vital step. By doing this, the researcher was able to clearly discern important data patterns and derive insights. The themes were evaluated for a good fit as the final step. Important qualitative data variables were made visible through these steps and procedures which made finding themes simpler.

Statistical Treatment - The quantitative data primarily came from the jurors' validation and responses. The study employed statistical tools such as sum and mean.

Sum. It was used to get the total score of project-based learning activities from the evaluation rating sheet of print resources of DepEd's LRMDs on the following factors: content, format, accuracy, and up-to-datedness of information.

Mean. It was used to express the jurors' average ratings on the instruments used in the study particularly the evaluation tool on developed project-based learning activities in terms of alignment to the MELCs and presence of features.

Teacher-Observers. The students were observed while accomplishing the activities. Teacher-observers were also participants in the conduct of this study. It is composed of three (3) female teachers who belong to the age group of 25-30 years old. The qualifications are: they should be teaching Biology and have more than three (3) years of teaching experience. The convenient sampling method was utilized for it requires the availability of the respondents in observing the students through video conferencing using Google Meet. The students also sent videos to the group chat while doing the activities. The responses of the teacher observers served as one of the data sources for determining the students' experiences.

4. Results

4.1 Developed Project-Based Learning Activities

The COVID-19 pandemic has created significant challenges for educators and students alike. Although educators have spent countless hours designing and enhancing online and hybrid instruction to reach students who are attending school remotely, evidence suggests that many students are still falling behind in their learning, despite these efforts. A closer look at the problem suggests that engaging students in remote learning is the key. Project-based learning (PBL) offers a solution. Project-based learning is an instructional strategy in which students learn by actively engaging in real-world projects that are personally meaningful to them. In this study, the researcher developed seven project-based learning activities. The activities are based on the most essential learning competencies (MELCs) of the K to 12 Basic Education Curriculum of the Department of Education. Since there is only limited time allotted for the quarter and some unexpected interruptions happened during the implementation of this study, only some selected competencies were considered in making the project-based learning activities.

There were seven (7) most essential learning competencies considered. These were under the content area of Cell, Cell Cycle, and Cell Membrane. There was one (1) PBL activity made for every competency. The most essential learning competencies considered were the following: describe the structure and function of major and

subcellular organelles; distinguish prokaryotic and eukaryotic cells according to their distinguishing features; classify different cell types (of plant/animal tissues) and specify the functions of each; describe the stages of mitosis/meiosis given $2n=6$; explain the significance or applications of mitosis/meiosis; identify disorders and diseases that result from the malfunction of the cell during the cell cycle; and describe the structural components of the cell membrane. The developed project-based learning activities were also based on the performance standards indicated in the K to 12 Basic Education Curriculum Guide. This includes the performance standard for the content area of the cell that is to construct a 3D model of a plant/animal/bacterial cell using recyclable materials. Another one is in the content area on the cell cycle, which is to construct a cell membrane model from indigenous or recyclable materials. The given duration for every activity is good for two (2) weeks.

The most essential learning competencies are the primary considerations in the design of the project-based learning activities. These are the main ideas and skills that are expected of students to master. In other words, these are the goals or objectives. The activities also contain the following key features: key knowledge, understanding, and success skills, challenging question, authenticity, reflection, and public product. These are adapted from the elements of project-based learning presented by the Buck Institute of Education. These features can be seen in the developed project-based learning activity sheets.

Key Knowledge, Understanding, and Success Skills. A project should be focused on student learning goals. It should also include standards-based content and skills. These skills include critical thinking, collaboration, communication and creativity and innovation. The activities developed the ability to make thoughtful decisions and exercise reasoned judgments to achieve the success skill which is critical thinking. The activities should provide an opportunity to work together or practice collaboration in answering the questions and in the development of the project. It should develop communication, the ability to discuss and share thoughts, questions, ideas, and solutions. It should develop creativity and innovation among students, the ability to generate ideas, things, method or products that have value. These skills were exhibited by the students through the duration of the activity.

Challenging Problem or Question. These are the meaningful problems to solve or a question to answer, at the appropriate level of challenge for students, which is operationalized by an open-ended, engaging driving question. There are different challenging questions to answer in every activity. This question or problem serves as their starting point in doing the activity or project. It gives the students an idea of what their task will be all about.

Authenticity. It is observed when the project has a real-world context, uses real- world processes, tools, and quality standards, makes a real impact, and/or is connected to students' concerns, interests, and identities. The authenticity of the project relies on the task given to the students.

Reflection. Reflection provides opportunities for students to reflect on what and how they are learning, and on the project's design and implementation. All project-based learning activities require the students to share their reflections.

Public product. Public product requires students to demonstrate what they learn by creating a product that is presented or offered to people beyond the classroom. It is also a way for students to apply what they have been learning to something beyond themselves. All project-based learning activities require the students to present their output not just to the class but to other people. However, due to the existing pandemic, face-to-face classes are limited and students were not allowed to go outside. Outputs were presented in public through social media such as YouTube and online platforms such as Messenger and Google Classroom.

The project-based learning activities had the key features to promote deeper learning, greater engagement, and high-quality work. When project-based learning is effectively programmed and scaffolded, this can have significant impact on the students and teaching practices. The activities had their own format namely: I. Cover Page; II. Key knowledge and understanding and success skills; III. Challenging question; IV. Task; V. Duration of activity; VI. Reflection; VII. Public product; VIII. Scoring rubrics.

4.2 Jurors' Evaluation of the Developed Project-based Learning Activities

Delivering an effective education to all students is a shared responsibility. To achieve success, publishers, schools, and all levels of government must work together to ensure that every teacher and student has access to a range of high-quality instructional materials (Dohle, 2015). In this study, the experts assessed the developed project-based learning activities that served as an instructional tool in teaching STEM 11 General Biology. The project-based learning activities were validated by ten (10) jurors in terms of DepEd standards, alignment to the most essential learning competencies, and presence of features. The activities obtained a passing rating and a descriptive rating of very highly evident on all these criteria which implies that the activities excelled at meeting the majority of the expectations as far as these criteria were concerned.

4.3 Student's Learning Experiences during the Process of Accomplishing the Project-based Learning Activities

The students' experiences in accomplishing the project-based learning activities were evaluated qualitatively using the students' journal entries and the teacher's observations. They were also supported by the students' outputs. This is presented by discussing their experiences in every project-based learning activity. The discussion includes the knowledge and skills gained, the tasks they have done, as well as the positive and negative experiences they have encountered. Project-based learning is an increasingly popular pedagogical practice centered on students working collaboratively on projects while the teacher facilitates learning activities and progression. It uses projects for teaching and learning. It provides students with opportunities to be central in learning, work autonomously over a given period of time with facilitation from the teacher, collaborate and cooperate to research and create projects, and reflect on their learning individually and as teams (Bell, 2010; Blumenfeld et al., 1991; Thomas, 2000).

In this study, it was observed that the students actively participated in doing the designed project-based learning activities through the use of technology specifically online platforms. Many studies also explored PBL and distance learning and have focused on how online tools and online forums can help facilitate PBL pedagogy. The use of technology supports the learning of students. Technology cannot wholly replace the school learning experience. However, it certainly makes teaching and learning a possibility when there are constraints on in-person learning like during the COVID-19 pandemic (Code et al., 2020; Peterson et al., 2020). Additionally, the students' interest in doing project-based learning activities and learning concepts increases when it is relevant to them. PBL also allows greater student autonomy. Online PBL instruction encourages students to practice autonomy and self-management skills over how they spend their time completing the project's goals. It also supports students to form connections with their peers. Feeling connected with others is an important motivational factor for student learning (Ryan & Deci, 2000).

4.4 Insights Derived by Students from their Learning Experiences

This study also aimed to get the insights of the students in accomplishing the project-based learning activities. The insights were analyzed through thematic analysis. Themes were identified from the students' responses in their journal entries. The researcher closely examined the data to identify common themes, topics, ideas, and patterns of meaning that came up repeatedly. The insights included the reflections, learnings, and even the feelings of the students as a result of their experiences in accomplishing the project-based learning activities. The students shared good and bad experiences in accomplishing the project-based learning activities which were supported by their outputs, journals, teachers' observations, and studies. From these learning experiences, students were able to develop insights.

5. Findings

Based on the analysis of the gathered data, the following findings were derived:

1. The seven (7) developed project-based learning activities focused on the most essential learning

competencies in General Biology 1 which are as follows: (a) describe the structure and function of major and subcellular organelles; (b) distinguish prokaryotic and eukaryotic cells according to their distinguishing features; (c) classify different cell types (of plant/animal tissues) and specify the functions of each; (d) describe the stages of mitosis/meiosis given $2n=6$; (e) explain the significance or applications of mitosis/meiosis; (f) identify disorders and diseases that result from the malfunction of the cell during the cell cycle; (g) describes the structural components of the cell membrane.

2. The activities adopted the key features of a good PBL from Buck Institute of Education, such as key knowledge, understanding and success skills, challenging question, authenticity, reflection, and public product. The seven project-based learning activities that were developed were the following: Visiting the Cell: Travel Brochure; 3D Cell Model Making; Cell Types: Interactive Graphic Organizer; Significance of Mitosis & Meiosis: Student-made Video Presentation; Mitosis & Meiosis: Student-built Model; Diseases and Disorders: Informative Flyers; and Cell Membrane: DEMOdel.

3. The seven project-based learning activities were given passing rates in all indicators using the LRMDS evaluation tool in terms of content, format, presentation and organization, and accuracy and up-to-datedness of information. The jurors also gave a very highly evident rating with a mean of 5 for all activities in terms of alignment to the most essential learning competencies. The jurors' assessment of project-based learning activities obtained a descriptive rating of very highly evident along all the features: key knowledge, understanding, and success skills with a mean of 4.99, challenging problem or question with a mean of 4.96, authenticity with a mean of 4.97, reflection with a mean of 5, and public product with a mean of 5. The activities got an overall rating of very highly evident, with a mean of 4.98.

4. The students' learning experiences during the process of accomplishing the project-based learning activities were evaluated qualitatively using the students' journal entries and the teachers' observations. Tasks were completed and observed in different stages. During the preliminary stage, the students read the modules and activity sheets, created a group chat in Messenger to communicate with classmates, started planning time-management strategies, and set a meeting with their group for planning. During the planning stage, the students brainstormed about the activity through Google Meet, did some research and brainstormed the answers to the challenging questions, and divided the tasks so everyone could participate. They also came up with a project design plan. During the development stage, students discussed and reviewed the answers to the challenging questions and started doing the task or project. Collaboration and communication among students were observed using online platforms such as Messenger group chat and video conferencing in Google Meet and Discord. They performed assigned tasks independently, sought critiques from groupmates to revise products, made video presentations to be shared with a broader audience, and formulated reflections. Lastly, during the presentation stage, the students discussed and presented the products created through video presentation and shared their reflections. Different web applications, such as Canva, PowToon, and PowerPoint, were used in the presentation. The students then assessed and gave feedback on other groups' presentations. Finally, they rated their created outputs and shared them as public products. The students also observed that the project-based learning activities helped them to have a deeper understanding of Biology concepts. They successfully exhibited the success skills such as communication, collaboration, critical thinking, creativity, and innovation. The students shared ideas and multiple points of view about the topics. Their self-confidence and literacy in online platforms and web applications were enhanced. They were motivated to learn the concepts in the activity. The students could practice autonomy and self-management skills in terms of how they spend time completing the project's goals.

5. Students derived insights from their learning experiences. Their insights were classified according to themes: the students found the activities fun and gratifying; students' misconceptions were cleared and corrected, making them appreciate the concepts better; and the activities challenged the students. Despite being challenging, the activities were still fun because they enhanced their creativity. The students practiced cooperation; understood the lesson better; enhanced their self-confidence and communication skills; and exhibited collaboration and creativity in performing the activities. They developed leadership skills and a sense of

responsibility and developed an appreciation of technology. The students also experienced some problems while accomplishing the activities and the activities were challenging for the students because it was hard for them to communicate and this kind of approach is new to them.

6. Conclusions

Based on the findings, the following conclusions were made:

1. The project-based learning activities were developed based on the most essential learning competencies in General Biology 1 and considered the key features of a good project-based learning activity.
2. The jurors' assessment of the project-based learning activities obtained a passing rating on all the criteria indicated in LRMDs— content, format, presentation, organization, accuracy, and up-to-datedness of information. The jurors also gave a very highly evident rating on all the criteria — alignment to most essential learning competencies and presence of features, which means the lessons met most of the expectations.
3. The students had good experiences in accomplishing the project-based learning activities observed in four stages: the preliminary stage, planning stage, development stage, and presentation stage. They exhibited successful skills such as critical thinking, communication, collaboration, self-management, creativity, and innovation. They found interest in doing activities that are relevant to them. They were encouraged to take control and ownership of their learning. They were provided peer-to-peer interactions even in online settings. Their confidence and skills in using technology were enhanced.
4. The students had various learning experiences which likewise developed different insights. Some of them were positive while a few were negative. Project-based learning can help students have better and more meaningful learning in distance education.

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