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Project-Based Digitized Module in Enhancing Scientific Competencies among Distance Learning Students

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Abstract

This study was designed to develop a project-based digitized learning module to enhance scientific competencies among distance learning Grade 10 students in San Pablo City Integrated High School. The study utilized a descriptive-developmental research design. The researcher developed a digitized learning module based on a project-based learning strategy. This strategy was incorporated within the layout of activities included in the module. The module was created through the koto bee author application. Based on the results, the data revealed that most of the respondents agree that the elements of the project-based approach are integrated into the module. Learners perceived or "agreed" that the developed material is effective in terms of objectives; usefulness; content; presentation; and, format, and language. The majority of the learners show agreement that they perceived the effectiveness of the developed Material in terms of usage, ease of use, user satisfaction, and attitude. Between the pretest and post-test scores of the respondent, it can be inferred that there is a significant difference since the p-value of 0.000 is less than 0.05. It can be determined that there is a significant improvement in the level of scientific competency skills of the students that undergoes the project-based digitized module. The overall perception of the incorporation of project-based digitized modules has a significant positive relationship with scientific competency skills. It suggests that crafting digitized modules in the context of project-based learning can be an effective tool in improving learners' scientific competency skills. Since it was found that there is a significant link between the project-based learning module and the scientific competencies of the learners, the aforementioned strategy may be used in the teaching-learning process to strengthen learners' capability to improve their science skills.

Keywords: Descriptive-developmental research, Project-Based Learning, Digitized Leaning Module, Scientific Competencies, Distance Learning, San Pablo City, Laguna

Introduction

The Department of Education as a whole envisions child-centered, value-driven, and high-functioning Filipinos that can think meaningfully and contribute to our nation. As the sector of education pursues its "Sulong Edukalidad" programs which clearly state the initiative to give quality education that

gears up the progress of the students, the higher skills processes of differentiating, evaluating, and creating serve as the driving force to its success.

Many higher education institutions around the nation have therefore decided on proactive strategies to guarantee that education continues despite the closure to meet the demands of students. Distance learning has been the primary go-to of the educational sector as the pandemic progresses. It is indeed destined to alter the current educational paradigm as the Internet blurs the line between near and far. Distance learning is any learning that takes place while the students are not physically present in the classroom. Aside from modular modality, which is the primary modality preferred by many Filipino students, online distance learning is another option. These regulations incorporate modified forms of online learning to streamline student learning activities. Online learning includes asynchronous, delayed-time activities including time-independent exams and pre-recorded video lectures (Oztok et al., 2013).

Moreover, the diversity of learners leads educators to find effective learning strategies that will enable the progress of the learning process Through engaging projects that are based on obstacles and problems encountered in the real world, project-based learning is a teaching technique that enables students to develop their knowledge and abilities. As Kokotsaki (2016) defined it, the active, student-centered approach to learning known as project-based learning places a strong emphasis on the autonomy, productive inquiries, goal-setting, cooperation, communication, and reflection of students within the framework of real-world activities. This way of instruction is very useful, especially in a student-centered classroom such as distance learning. As educators adapt to the "new normal", the focus on delivering education in digital classrooms was heightened. Teachers want to find new ways how to deliver a more exciting and effective classroom.

Many of today's science curricula do not adequately teach students to assess the quality of scientific sources and analyze evidence to make informed conclusions regarding scientific assertions (Porter et al., 2010). According to the Programme for International Student Assessment (PISA), scientific literacy is the ability to apply one's knowledge of scientific concepts, facts, and processes to new situations, some of which may not be scientific (PISA, 2018). Scientific competencies are one part of scientific literacy, and they are defined as a set of abilities that reflect a belief that science is best viewed as a collection of social and epistemic processes that are shared across all of its subfields.

In reading, mathematics, and science, Filipino students performed lower than the OECD average. In the Philippines, 22% of students received a Level 2 or higher in science, although hardly any of them were top achievers. One of the lowest PISA participant countries and economies has a mean scientific performance score of 357. The nation is ranked 76th among the 77 participant nations (OECD, 2019).

According to research on learning sciences (National Academies of Sciences, Engineering, and Medicine, 2019; NRC, 2007), it is important to create learning environments that immerse students in real-world situations where they can apply their knowledge of various disciplines as well as scientific and engineering principles to understand how natural phenomena occur. In this study, it is suggested that one platform for fostering scientific competencies is project-based learning.

DepEd has released documents on flexible learning and materials following its legal mandate, most notably DepED Order No. (DO) 21.2019 or the Policy Guidelines on the K–12 Basic Education Program. Flexible learning options (FLOs) are a variety of delivery methods and learning materials that may be adapted to a learner's needs, context, and individual circumstances. The development of such material that will help enhance students' performance will be explored.

The project-based learning strategy may be applied to enhance scientific competency and disaster soft skills in the distance learning modalities. Although physical interaction is limited nowadays, it could be applied through the development of a digitized learning module for the fourth grading period.

Objectives of the Study

This study aimed to develop a project-based digitized learning module to enhance scientific competencies among distance learning Grade 10 students in San Pablo City Integrated National High School.

Specifically, the study was conducted to 1) Determine how the student respondents describe the incorporation of the Project-based Design Elements of the developed material in terms of a) problem/question; b) sustained inquiry; c) authenticity; d) student voice, and choice; e) reflection; f) critique and revision; and, g) public product. 2) Determine how the student respondents describe the effectiveness of the Developed Material be described in terms of a) objectives; b) content; c) format and language; d) presentation; and e) usefulness. 3) Determine how the student-respondents perceive the effectiveness of the developed Material through the technology acceptance model in terms of a) perceived usefulness; b) perceived ease of use; c) user satisfaction; and d) attitude. 4) Determine the pretest and posttest scores performance of the students in the scientific competency test. 5) Determine if there is a significant difference between the pretest and post-test scores of the respondents exposed to the project-based digitized learning module. 6) Determine if there is a significant relationship between the perceived acceptability of the project-based learning material and students' level of scientific competency.

Methodology

The study employed a descriptive-experimental research design. The respondents of this study consisted of Grade 10 distance learners of San Pablo City Integrated High School The respondents of this study were chosen through a purposive sampling method. They consisted of Grade 10 distance learners of San Pablo City Integrated High School. The researcher used one section in Grade 10 under the online distance learning modality. Lessons included in the study will be taken up in the fourth quarter period through online distance learning modalities. The project-based digitized learning module was made through an online app. The content of the material was based on the most essential learning competencies for the 4th quarter. The material to be developed contains the design elements of project-based learning.

The researcher used both descriptive and inferential statistics. A survey questionnaire was used as the main tool in collecting data for the study. Frequency count, mean and standard deviation will be used to describe the perception of the respondents on the effectiveness of the developed material and to describe the scores of the respondents in the pretest and posttest. The construction of questions and type of test was adopted in the 2018 Programme for International Student Assessment (PISA).

The t-test was used to determine whether significant differences exist between the pretest and posttest scores in the scientific competencies test of the respondents. Moreover, to determine if a relationship exists between the acceptability of the developed material and the level of scientific competencies of the students, Pearson product-moment correlation was utilized.

Results and Discussion

1. Students' Perception of the Incorporation of the Project-based Design Elements on the Developed Project-Based Digitized Module

Exhibited in Table 1 is the student's perception of the incorporation of the project-based design elements on the developed project-based digitized module. The data revealed that most of the respondents agree that the elements of the project-based approach are integrated into the module. The respondents agreed that the student's voice and choice and reflection elements are well presented with the highest mean of 3.93 with the verbal interpretation of agree.

Table 1
Students' Perception on the Incorporation of the Project-based Design Elements on the Developed Project-Based Digitized Module

Indicators	Mean	SD	Verbal Interpretation
1. problem/question	3.73	1.081	Agree
2. sustained inquiry	3.90	.995	Agree
3. authenticity	3.83	1.085	Agree
4. student voice and choice	3.93	1.081	Agree
5. reflection	3.93	1.112	Agree
6. critique and revision	3.77	1.040	Agree
7. public product	3.77	.971	Agree
Overall	3.84	.963	Agree

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Moderately agree); 3.50-4.49 (Agree); 4.50-5.0 (Strongly Agree)

The result implicated that when students should be given the opportunity to reflect on what they are learning, how they are learning, and what they have accomplished. Also, the students appreciate the module and lesson more when they are given choices about the products to be created, how they work, and how they use their time, guided by the teacher and depending on age level and project-based experience.

Choices for students of all ages have been demonstrated to increase intrinsic motivation, according to Manzano (2009). Choice has also been linked to improved task performance, student effort, and subsequent classroom learning. Students who are explicitly taught metacognitive skills, such as written self-reflection, tend to be more strongly engaged in their academic work and retain higher levels of academic performance, according to a study by McCormick, Dimmitt, and Sullivan (2013). Reflection must be included in the module for these reasons.

2. Students' Perception of the effectiveness of the Developed Project-Based Digitized Module

Table 2
Overall Students' Perception on the effectiveness of the Developed Project-Based Digitized Module

Indicators	Mean	SD	Verbal Interpretation
1. Objectives	4.00	1.114	Agree
2. Content	4.03	1.159	Agree
3. Format and Language	4.00	1.145	Agree
4. Presentation	4.00	1.114	Agree
5. Usefulness	4.07	1.081	Agree
Overall	**4.02**	**1.083**	**Agree**

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Moderately agree); 3.50-4.49 (Agree); 4.50-5.0 (Strongly Agree)

Table 2 shows that the module's overall perceived effectiveness is shown through the agreement of the students of the presence of objectives (mean=4.00), content (mean=4.03), format and language (mean=4.00), presentation (mean=4.00), and usefulness (mean=4.07) of the developed module. It can be inferred from this result that the project-based digitized module possesses the qualities of a good and effective module. Through the agreement of the students, it can be inferred that the developed module has all the requirements for good instructional material because it contains the following: 1) Objectives, 2) Content, 3) Format and Language, 4) Presentation, and 5) Usefulness.

Excellent learning objectives serve as a roadmap for students as they review their course information and get ready for exams. The most effective learning objectives are those that are both actionable and measurable. An effective module with an attainable objective improves the performance of students. On the other hand, as agreed by the students, the proper integration of content makes them understand and associate the content with classwork which means students make helpful connections between their previous learning experiences, the content, and the assigned classwork. Format and language, the presentation as well as the usability of the module can be associated to the eagerness of the students to learn. As agreed by the students as these components of module development is well integrated, they appreciate the module mo. These components enable the students to understand and use the module with ease, therefore, stimulating learning.

According to Mercedes (2016), a module needs to have a statement of purpose, desirable prerequisite skills, instructional objectives, module implementers, the modular program, associated Experience, an evaluative pretest, and a module assessment.

3. Students' Perceived Technology Acceptance of the developed Project-Based Digitized Module

Table 3
Students' Perceived Technology Acceptance of the developed Project-Based Digitized Module

Indicators	Mean	SD	Verbal Interpretation
1. Perceived Usefulness	3.97	.902	Agree
2. Perceived Ease of Use	3.91	.914	Agree
3. User Satisfaction	3.97	.852	Agree
4. Attitude	3.86	.987	Agree

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Moderately agree); 3.50-4.49 (Agree); 4.50-5.0 (Strongly Agree)

As shown in table 3, the students perceived that the digitized module is useful and satisfied users with the highest mean of 3.97 and a standard deviation of 0.902. The module allows the students to accomplish learning tasks more quickly, enhances learning, increases productivity and improves performance. The module, therefore, gives more advantages to the student's learning experience as they go along the lesson. To attain the desired learning outcome, digital teaching strives to have students actively participate in learning activities. Because of this, the design of educational activities and the adaptable use of technology tools or digital learning have emerged as the main concerns for today's information technology-integrated education (Pai & Tu, 2011).

It is also shown through the data in the table with a mean of 3.86 and a standard deviation of 0.987 that the students agreed that through the use of the module, their outlook towards learning is uplifted.

The emotions and sentiments about learning science indicate the fascination part of science (Zhang and Tang, 2017). The self-efficacy component of the scientific attitude refers to students' perceptions of their abilities to succeed in courses with scientific content, be qualified for jobs involving science, and successfully execute science-related tasks (Larson et al., 2014). As the students agreed on developing a

positive attitude towards the use of the module, it can be implied that they encounter a pleasant experience and therefore enjoyed learning through the module.

4. Students' pretest and post-test scores performance in the scientific competency test

Table 4
Students' pretest and post-test scores performance in the scientific competency test

Scientific Competency Scores	Pretest		Posttest		Verbal
	Frequency	Percent	Frequency	Percent	Interpretation
74 and below	20	66.7	-	-	Beginning
75-79	9	30.0	7	23.3	Developing
80-84	1	3.3	7	23.3	Approaching Proficiency
85-89	-	-	9	30.0	Proficient
90 and above	-	-	7	23.3	Advanced
Total	30	100	30	100	

Table 4 presents the pretest and posttest scores performance in the scientific competency test of the students. Before the implementation of the digitized module, 20 students out of 30 students, or 66.7% of respondents are beginning. None of the respondents shows proficiency or advanced scientific competency skills. On the other hand, after the implementation of the digitized module, none of the students falls into the beginning category. They show a significant increase in learning proficiency. Nine students representing 30% of the respondents became proficient and 23.3% 0r 7 respondents became advanced learners. Through the presented data, it can be drawn out that the implementation of the digitized module caused a significant improvement in the scientific competency skills of the students.

This can be in alignment with the study of Siano & Potane (2022) where the effectiveness of e-books was explored in teaching Mathematics to improve students' academic achievement. Results showed that after using the interactive e-book, students attained a satisfactory level.

5. Difference between the pretest and post-test scores of the respondents

Table 5
Test of difference between the pretest and posttest scores of the respondents

	Pretest		Posttest		t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Scientific Competency	14.37	3.792	22.67	8.727	5.111	29	.000

if $p \leq .05$ (significant); if $p > .05$ (not significant)

Table 5 presents the Test of difference between the pretest and posttest scores of the respondents. A dependent t-test was conducted to determine if there is a significant difference between the scientific competency pretest and post-test performance scores of the respondents. The table shows that the pretest has a mean score of 14.37 (sd=3.792), while the posttest has a mean score of 22.67 (sd=8.727). It can be inferred that there is a significant difference between the pretest and posttest score of the respondent. It an

be determined that there is a significant improvement in the level of scientific competency skills of the students that undergoes the project-based digitized module.

The results of the analysis, as reported by Siano & Potane's study from the year 2022, revealed that there was a statistically significant difference in the children's test scores before and after the intervention. When using an interactive e-book to increase their knowledge, students are inspired to learn. The interactive e-book provided students with a great learning opportunity. The findings suggested that student's academic performance significantly improves when given the chance to reflect on what they are learning, how they are learning it, and what they have done. Additionally, when given alternatives regarding the materials to be generated, how they will work, and how they will utilize their time, under the guidance of the teacher and following their age, the students are more appreciative of the module and lesson. Additionally, when given options regarding the final goods, how they are made, and how they use their time under the guidance of the teacher and following their level of development and prior project-based learning, students are more appreciative of the module and lesson. The utilization of the digital module might be inferred as giving the students a platform to enhance their academic achievement.

6. Acceptability of the project-based learning material and students' level of scientific competency

Table 6
Perceived acceptability of the project-based learning material and students' level of scientific competency

	Scientific Competency
Incorporation of Project-based Design Elements	
Problem/Question	.305*
Sustained Inquiry	.365*
Authenticity	-
Student Voice and Choice	-
Reflection	-
Critique and Revision	.417*
Public Product	-
Overall	.306*
Effectiveness of the Developed Material	
Objectives	.279*
Content	-
Format and Language	-
Presentation	-
Usefulness	.420*
Overall	-
Technology Acceptance	
Perceived Usefulness	.187
Perceived Ease of Use	.061
User Satisfaction	.155
Attitude	.298

***Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).*
Verbal Interpretation of r-values: +1.0 Perfect positive +/- association +0.8 to +1.0 Very strong +/- association +0.6 to +0.8 Strong +/- association +0.4 to +0.6 Moderate +/- association +0.2 to +0.4 Weak +/- association 0.0 to +0.2 Very weak +/- or no association

Table 6 presents the test of the relationship between the perceived acceptability of the project-based learning material and students' level of scientific competency. As the results, presents, the scientific competencies skills of the respondents in terms of interpreting data and evidence scientifically, exhibit a moderate correlation with Problem/question (r=.412, p<0.05) and Critique and Revision (r=.379, p<0.05). This result indicates that the integration of a good open-ended question that students understand and find intriguing, which captures their task or frames their exploration, giving and receiving feedback on the quality of their work has improved the student's ability on analyzing and assessing evidence, claims, and arguments in various formats, as well as reaching suitable scientific findings.

Also, it can be deduced from the data that the scientific competencies skills of the respondents in terms of explaining phenomena scientifically exhibit a moderate correlation with the overall effectiveness of the developed digitized module. It can be interpreted from the data that the integration of important parts of a digitized module, the usefulness as well as the interactive aspect of the module enables the students to recognize, propose, and evaluate explanations for a variety of natural and technological occurrences.

As the results present, Critique and Revision (r=.417, p<0.05), exhibit a moderate correlation with the overall scientific competencies skills of the respondents. For instance, in lesson 1 of the project-based digitized module, the students were tasked to create a project that show the mechanism of Boyle's and Charles' Law. After the students outlined the project, they submitted a copy through google link. Then the teacher gave comments and critiques for improvements. The students then continue to finish the project. This implies that as the students create their projects, they learn and appreciate more the learning experience through critiques or comments given by the teacher. Through this, the students gather more ideas and eventually give them a better layout of their project resulting in more comprehensive learning.

Before crafting the project, the students were given specific objectives/ problems to attain/answer. This serves as a guide to what the project should contain and what purpose it should serve. Video lessons and specific instructions for the tasks are also provided in the module. This guides the students as to how the task should be done and to what extent of knowledge they need. The result of correlation shows for the Problem/Question (r=.305, p<0.05). and Sustained Inquiry (r=.365, p<0.05), it can be implied that the more the problem/question is incorporated the students have a better understanding of their lesson because they can define the objective of the lesson. Also, as the students were given an extended, rigorous process of asking questions, using resources, and developing their answers, the students increases their understanding of the lesson, therefore, enhancing their scientific competency skills.

In alignment with Markham (2012), he states that project-based learning is a constructivist approach that focuses on project-based learning. It aims to promote deep learning by allowing students to employ a strategy to engage with topics and questions that are founded on inquiry that is rich, authentic, and pertinent to the subject at hand.

The overall incorporation of project-based design elements has a weak positive correlation to scientific competency skills (r=.306, p<0.05). The result shows the enhancement in the scientific competency skills of the students. The results can be interpreted that as the project-based design elements are well incorporated into the module the students show a positive attitude and acceptance toward the use of the module. According to Rusilowati (2019), the scientific method model is a type of learning paradigm that can help students develop their project-based learning, problem-based learning, cooperative learning, discovery, and inquiry abilities. Additionally, Utami (2021) found a significant difference between employing project-based learning and the direct instruction paradigm in chemistry when it comes to enhancing students' practical knowledge and scientific literacy.

On the other hand, there is a weak positive correlation between the effectiveness of the module objectives ($r=.279$, $p<0.05$) and usefulness ($r=.420$, $p<0.05$) to the scientific competency skills. This result indicates that when a module has a well-defined objective, the students find it easy to use and therefore results to learning. Also, since the developed project-based module is designed through a digitized platform, the usefulness of the module is very important to the learning of the students. The way the module was manipulated and presented gives the students additional learning experience. Through e-learning, objectives can be met in the shortest amount of time with the least amount of work. When it comes to managing the e-learning environment, its impact on educational learning may be seen in ensuring that everyone has equitable access to information. E-learning also empowers students or learners to rely on themselves, enabling teachers to serve as advisers and guides rather than the exclusive source of information (Joshua et al., 2016).

With regards to the relationship between Technology acceptance of the digitized module and the scientific competencies skills of the students, there is no significant relationship exhibited between the variables. In summary, the overall perception of the incorporation of project-based elements in the digitized module has a significant positive relationship with scientific competency skills. It suggests that crafting digitized modules in the context of project-based learning can be an effective tool in improving learners' scientific competency skills.

Based on the results, the data revealed that most of the respondents agree that the elements of the project-based approach are integrated into the module. Learners perceived or "agreed" that the developed material is effective in terms of objectives; content; format and language; presentation; and, usefulness. The majority of the learners show agreement that they perceived the effectiveness of the developed material in terms of usage, ease of use, user satisfaction, and attitude. The student-respondents perceived the effectiveness of the developed project-based digitized module through the technology acceptance model in terms of perceived usefulness, perceived ease of use, user satisfaction, and attitude. There is a significant difference between the pretest and post-test scores of the respondent. It can be determined that there is a significant improvement in the level of scientific competency skills of the students that undergoes the project-based digitized module. The overall perception of the incorporation of the project-based digitized module has a significant positive relationship with scientific competency skills. It suggests that crafting digitized modules in the context of project-based learning can be an effective tool in improving learners' scientific competency skills.

Conclusions

According to the study's findings, the following inferences can be made about the student's performance in terms of their scientific competence between the pretest and posttest scores: Therefore, the put-out null hypothesis cannot be supported. The perceived acceptability of the project-based learning module, in terms of the incorporation of the project-based design elements and the efficiency of the created material, is significantly correlated with students' degree of scientific competence. Therefore, the put-out null hypothesis cannot be supported.

Recommendations

Since it was found that there is a significant link between the project-based learning module and the scientific competencies of the learners, the aforementioned strategy may be used in the teaching-learning process to strengthen learners' capability to improve their science skills. Since the study delivers

a positive conclusion, the school heads and other key officers may conduct SLAC sessions or in-service training that would consider the use of project-based modules as one of the teaching supplements that may be used in education whether in distance education or face-to-face setup. Future researchers may conduct the same study in a wider scope, in a longer period, in different learning modalities, and in other learning areas or disciplines.

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