Development And Validation Of Project-Based Module For Selected Topics In Biology

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Abstract.
This paper focused on the development of validation of a project-based learning module for selected topics in Biology. Project-Based Learning is deemed to promote holistic development of the learners especially in relation to biology for junior high school. The development phase involved the identification of the least learned competencies in biology that involved topics about cells, microorganism, digestive system and biodiversity, photosynthesis, cellular respiration, and ecosystems and evolution. The development phase also involved the formulation of the general layout of the module as well as the creation of project-based learning activities, as well as other related exercises and activities and rooms or reflections, and conclusions. The module is described according to the module design, module content, and the project-based learning content. The module design is characterized into the cover page, preface and table of contents, and the module content per grade levels themselves. For the module content, it involved the activities, lessons, exercises, and projects that come with each of the topic per grade level. Lastly, the PBL content focused on the structure of Project-based learning itself, which deemed to promote holistic learning among the learners especially when it comes to other skills such as creativity, problem-solving skills, and critical thinking. The learning module also underwent the process of validation. There were ten identified validators for the learning module who were given a set of rubrics that assisted them in terms of evaluating the researcher-made project-based learning module. Through the validation process, the module was marked as excellent, as all the expected elements of the modules were met.

Keywords: *Project-Based Learning, Biology, Development, Validation, Reliability, Readability*

I. INTRODUCTION

Project-Based Learning (PBL), as defined by Buck Institute for Education, is referred to as a teaching method in which students gain knowledge, understanding and skills by working for a certain amount of time to work on and respond to an authentic, engaging, and complex question, problem, or challenge. Learning through the development of projects is said to be vital in the development of students. Learners must perceive the work as personally meaningful, and as a task that matters, and that they want to do well. A meaningful project fulfills an educational purpose. Well-designed and well-implemented project-based learning is meaningful in both ways [1]. While it was noted that the implementation of PBL in the classroom could boost the enthusiasm of students when it comes to completing their academic tasks [2]. Also, PBL is designed to improve student collaboration, creativity, engagement, as well as their academic performance in specific topics and units. These are then some of the reasons why the implementation of Project-Based Learning should be considered in the

classroom. However, there are still some misconceptions when it comes to project-based learning. Involving tasks and projects in the learning experience of the students does not automatically equate into project-based learning. PBL must lead students and learners into solving complex problems that would require solutions to be formulated by the students which they will present at the end of their learning experience on a particular unit or topic [3].

In PBL, the teacher's role involves being a guide in the learning process. The driving question, as well as the problem, will lead the students in learning as well as looking for solutions on the said challenges and problems. It is then the reason why Project-Based Learning is considered as a student-centered methodology [4]. In line with this, the researcher intends to develop a validated project-based learning module in teaching selected topics in Biology.Biology is said to be the scientific study of life. Studying biology leads to the understanding of the world around us, as well as how our overall biological systems work, together with the interaction between the biotic and abiotic factors in our environment. Through biology, we can open new doors for improvement and development in terms of our quality of life, as well as our environment. Moreover, we get to learn more about the different biological processes not only in our body but in our environment as well. These are some of the notable reasons why studying and learning biology is essential [5]. Biology is offered in almost all curricula all around the globe. It serves as a foundation of other science courses even in medicine. The science of life also gave birth to other similar studies such as biochemistry, biotechnology, zoology, botany, and other related sciences.

With this, it is imperative that we develop high regard in pursuit of learning biological sciences [6].In the Philippines, biology is previously taught in the second-year high school during the time of the basic education curriculum. It is the curriculum that was superseded by the current curricular program by the Department of Education [7]. With the recent development of the current curricular program of the Philippines, biology is now a part of the K to 12 programs by the education department. Besides this, topics in biology are distributed in junior high school and senior high school from grade seven all the way to grade twelve. Topics in biology can be taught in several ways, such as through a teacher-centered strategy, or a student-centered strategy [8].PBL can be manifested using a module by a facilitator. A module contains the contents of the lesson, as well as competencies that are targeted to be learned, as well as the activities that are to be accomplished by the students. Using modules in class, teachers will serve as facilitators for the activities.To sum up, the researcher has written and accomplished a project-based module intended for selected topics in Biology at Junior High School level to aid student learning. This is different from other modules since the researcher-made module is only composed of PBL content.

II. METHODS

The development and validation of the modules involved the following stages: preparation, development, and finally, validation stage. The preparation stage involved the determination of the topics in Biology that are to be selected. The researcher has referred to Science teachers at Bataan Christian School, Philippines about the topics and competencies in Biology that are least learned. Moreover, the study also has sought permission from the school principal to obtain such data thus the data preparation is an integral step to generate insights [9]. Having data in hand can help researchers formulate proper research problems and scenarios, thus helping them to see through possibilities to look for areas of improvement when it comes to the research paper. In addition, with the selection of the topics in Biology, the outline, and the format of the learning module itself are considered as well. The researcher has the following items as components of the researcher-made module: project-based activity, project background, general objective, learning goals, mechanics, and procedures of the project, as well as generalizations, conclusions, and reflections. Another study also highlighted that learning materials should have defined goals, as well as coherence among the learning goals, activities, discussions, and assessments must be evident in the said learning material [10]. With all of these, the researcher has considered these to develop a sound and proper learning module.

After the preparation stage, the researcher proceeded to the development stage for the learning module. The module development phase involved the process of writing the learning material itself. This process involved the formulation of learning goals, as well as project background, creating guide questions, procedures, and mechanics for the project and lastly generalizations, conclusions, and reflections. The given projects and activities must be appropriate for the competencies, as well as the capabilities of the learners. This line of thought is essential for 21st-century education. The 21st-century skills are more important to students now than before [11]. Hence, academic instruction must always be open for student-centered methodologies so that the development of their 21st century skills will be encouraged. The usage of well-developed and well-structured module will help teachers facilitate the learning of their students; moreover, the learners will also be exposed to different activities that could develop their 21st-century skills.Lastly, the development phase of the learning module has been succeeded by the process of validation. The process of validation involved the careful and thorough examination of the project-based module by experts in the field. Moreover, the reliability and validity are fundamental concepts that help researchers evaluate how their measures work [12]. In this regard, learning materials like modules should be thoroughly checked to be able to determine whether the contents would be helpful not only to the learners but the facilitators of learning as well. The researcher-made module has been examined by education experts as well as those who are specified in the field of Biology. This process ensured that the outcome and the product

of this paper which is the module itself will be of appropriate use not only for the learners, but the teachers as well.

It is imperative for the study to ensure that all the components of the learning module are properly and thoroughly checked to minimize possible errors and to determine rooms for improvement to ensure that it would be of use to the academic community.The study has referred to experts in specific fields for the validation of the Project-Based Learning Module. The validators of the study involved content experts who validated the module's design, characteristics, and specifications. In addition, for the biology content of the researcher-made module, experts in the field have been consulted as well. Such experts involved those that have specialization in Biology, and seasoned teachers that are teaching Biology for five years or more. They investigated the topics and activities that were presented on the module. Lastly, the PBL contents of the researcher-made module were validated by experts in the field as well. They involved those that are well-versed in curriculum design and instruction, as well as those that are in a similar area in the teaching field that are considered as experts and consultants in the said endeavor.The data concerning the least learned competencies were obtained through the help of the curriculum officer-in-charge for Special Program for Science, Technology, Engineering, and Mathematics (SPSTEM) at Bataan Christian School Junior High School Department. Permission to obtain the data was sought from the principal as well.

For the content of the module, data were gathered for the learning objectives and goals for the selected topics in Biology in the curriculum guides that are provided by the Department of Education. This information was regarded as the established goals in the learning module. Aside from the learning goals, information for the discussions of topics as well as procedures for the project was collected and formulated by the researcher through the help of existing textbooks, online journals, and other related credible sources of information.The collected data and information were carefully and thoroughly checked by the researcher to ensure the qualities of being a good learning-module are met. This process was done even before subjecting the researcher-made module into the validation phase. These are then the process of data collection as well as analysis for this study. The development and validation of the modules involved the following stages: preparation, development, and finally, validation stage. The preparation stage involved the determination of the topics in Biology that are to be selected. The researcher has referred to Science teachers at Bataan Christian School about the topics and competencies in Biology that are least learned. Moreover, the researcher also has sought permission from the school principal to obtain such data. A published article stressed that data preparation is an integral step to generate insights [13]. Having data in hand can help formulate proper research problems and scenarios, thus helping them to see through possibilities to look for areas of improvement when it comes to the research paper. In addition, with the selection of

the topics in Biology, the outline, and the format of the learning module itself are considered as well.

The study has the following items as components of the researcher-made module: project-based activity, project background, general objective, learning goals, mechanics, and procedures of the project, as well as generalizations, conclusions, and reflections. This is in line with the thought in an article by [14], where he stated that learning materials should have defined goals, as well as coherence among the learning goals, activities, discussions, and assessments must be evident in the said learning material. With all of these, the researcher has considered these to develop a sound and proper learning module.After the preparation stage, the study proceeded to the development stage for the learning module. The module development phase involved the process of writing the learning material itself. This process involved the formulation of learning goals, as well as project background, creating guide questions, procedures, and mechanics for the project and lastly generalizations, conclusions, and reflections. The given projects and activities must be appropriate for the competencies, as well as the capabilities of the learners. This line of thought is essential for 21st-century education. The 21st-century skills are more important to students now than before. Hence, academic instruction must always be open for student-centered methodologies so that the development of their 21st century skills will be encouraged [15]. The usage of well-developed and well-structured module will help teachers facilitate the learning of their students; moreover, the learners will also be exposed to different activities that could develop their 21st-century skills.

Lastly, the development phase of the learning module has been succeeded by the process of validation. The process of validation involved the careful and thorough examination of the project-based module by experts in the field. The reliability and validity are fundamental concepts that help researchers evaluate how their measures work [16]. In this regard, learning materials like modules should be thoroughly checked to be able to determine whether the contents would be helpful not only to the learners but the facilitators of learning as well. The researcher-made module has been examined by education experts as well as those who are specified in the field of Biology. This process ensured that the outcome and the product of this paper which is the module itself will be of appropriate use not only for the learners, but the teachers as well. It is imperative for the researcher to ensure that all the components of the learning module are properly and thoroughly checked to minimize possible errors and to determine rooms for improvement to ensure that it would be of use to the academic community.

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III. RESULT AND DISCUSSION

The learning modules must have clear purposes for students intended for learning specific tasks required by the curriculum [17]. In addition, the learning module must also be constructively aligned meaning there must be coherence in part of the objectives, instruction, and assessment. Lastly, the module content itself must also be considered to promote holistic development among the learners.

Thus, with all validations and reviews done, here are now the presentation, analysis and interpretation of the data that were gathered from the course of this study.

Module Design

The module design is consisting of the cover page, preface and table of contents, as well as the content proper. These three categories were evaluated by the validators on the

scale of 1-4:

1 = POOR 2 = FAIR 3 = GOOD 4 = EXCELLENT

Rubric for Module Design

MODULE DESIGN	4	3	2	1
COVER PAGE				
The cover page background is relevant to the content and nature of the learning module				
Colors are pleasing to the eyes and show matching color schemes				
Text fonts style and size are readable				
PREFACE AND TABLE OF CONTENTS				
Text content and figures font style and sizes are readable				
Headings show consistency and manifest proper color schemes				
Headings support content and preview what is expected by the reader				
CONTENT PROPER				
Headings and subheadings support and preview what is expected by the reader				
Content and figures text font styles and sizes are reader-friendly				
Provided figures help the readers to have a better look to the topics and discussions				
The text is complemented and supported by graphic elements that follow less-is-more rule; they do not crowd too much textual or visual information				
The point size of the text, length of the line of text, and space between each line all work together, producing a page that is not only visually appealing, but also readable and accessible				
Graphics are located with the text that they refer to, rather than pages before or after it				
Graphics are consistently identified with call outs such as figure 1, figure 2, etc.				
Each photograph includes a caption that succinctly identifies it and makes a direct connection between it and the text				
Writing is descriptive and thought-provoking, fosters visualization, and sparking the reader's imagination on many levels				
Vocabulary consists of words that are both familiar and challenging, and words the reader may not know are clearly defined				
Key ideas and main points supporting the concepts discussed in the topics are clear and accurately stated				
Includes relevant activities which offer sufficient practice, so that the students can reinforce and retain what has been done				

Results of the Evaluation by the Validators on Module Design

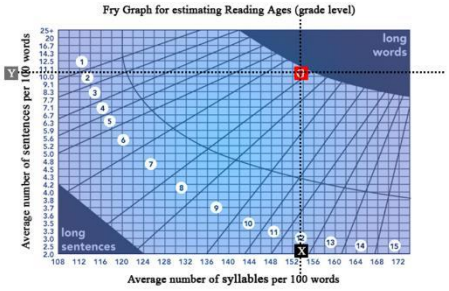
Validators	Value	Description
1	3.3	Excellent
2	4	Excellent
3	4	Excellent
4	3.9	Excellent
5	3.9	Excellent
6	4	Excellent
7	2.7	Good
8	3.9	Excellent
9	3.3	Excellent
10	4	Excellent
11	3.4	Excellent
12	3.7	Excellent
Overall Mean	**3.4**	Excellent

The overall mean for module design is 3.4 marked as excellent. Thus, the module can serve its purpose to the learners. In addition, as recommended by one of the validators, the preface was revised. Instead of discussing what biology and project-based learning are all about, the researcher revised it in a way that the preface focusses on expectations of the learners from the learning module. The learning modules must have appropriate designs, with clear objectives and features so that the modules could deliver each lesson and activity [18]. With proper design, the learning module can greatly help the teaching and learning process.

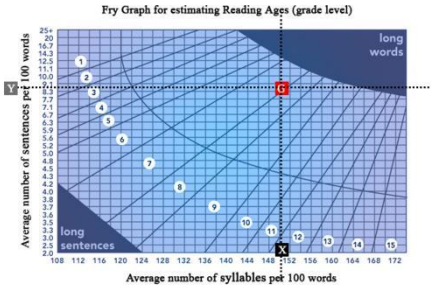
Readability of the Module

Readability is referred to as a measure of how easy an individual could read specific texts such as in book, modules, articles, and other learning materials [18]. It can include related elements such as complexity of the sentences, familiarity of the

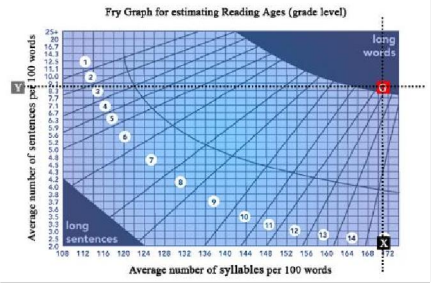
words, construction of sentences, and use of words. In this study, Fry Readability Test was used to determine the readability of the researcher-made module. Each of the grade levels, specifically from grades seven, eight, nine, and ten was subjected to Fry Readability Test. To ensure that the learning module will be readable to the age groups of each of the grade level, the researcher have considered the ages of the students that belong to each of the four grade levels.



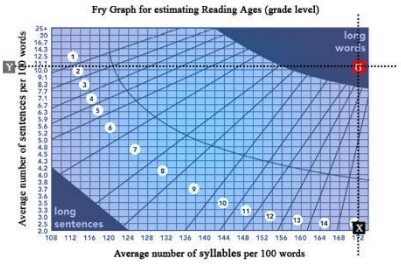
With the result of the Fry Readability Test, it is good to note that this portion of the module is readable for grade seven students.



With the result falling into around 11.5, the contents of this part of the module are readable for grade eight students.



With this result, the value fell to the age group of grades nine who were expected to use this module.



The result above shows that on the age group of fifteen to sixteen, the contents are readable for the learners.The results of the Fry Readability Test done on each of the grade level of the content of the project-based learning module, show that the texts of the module are readable for the intended users of the researcher-made module. With this development, the researcher has pushed through to the process of validation phase. The module was rated by the validators in terms of design, reliability, topics, and project-based learning content. The table below shows the descriptive equivalents of the resulted mean per category that were checked by the validators.

Reliability

The reliability of the project-based learning module for selected topics in biology is described by the provided aims, as well as the module's exercises and activities. The aims or the learning objectives and competencies were generally obtained from the curriculum guide provided by the Department of Education. These learning goals are expected to be learned by the students after every project they will accomplish. In addition, with this, the reliability of the module is also described by the exercises and activities as well. Such activities intend the learners to have mastery of the topic that they are going through. Criteria under reliability are found below with a scale of 1-4.

Rubric for Reliability

RELIABILITY	4	3	2	1
AIMS				
Extent of the module to correspond with the needs of students				
Extent of the module to do what it claims to do				
Extent of the aims and objectives of the module seem to be in tune with the curriculum guide				
Extent of the module's priorities match with the curriculum guide priorities				
Extent of the module to integrate development of different skills such as creativity, leadership, teamwork, and critical thinking				
Extent of the module activities to meet the objectives stated in the curriculum guide				
EXERCISES AND ACTIVITIES				
Extent of module to provide activities that promote development of study skills by the learners				
Extent of variation of module activities				
Extent of module activities to promote student communication				
Extent of the module to peovide meaningful activities for the learners				
Extent of the module to provide activities that incorporate pair or group work				
Extent of the module to provide project and activities that encourage research work by the learners				
Extent of the module to allow students to study on their own and outside of classrooms				
Extent of the module to provide activities that manifest procedural information and instructions				

Results of the Evaluation by the Validators in Relation to the Module Reliability

Validators	Value	Description
1	3.9	Excellent
2	4	Excellent
3	4	Excellent
4	3.2	Good
5	3.9	Excellent
6	4	Excellent
7	2.9	Excellent
8	3.5	Excellent
9	3.3	Excellent
10	3.9	Excellent
11	3.3	Excellent
12	3.0	Good
Overall Mean	3.6	Excellent

With the table above that shows seven out of twelve validators marked the learning module as excellent in terms of reliability, as well as the activities and exercises are reliable. In addition, the overall mean for all the evaluations for reliability also marked the module as excellent; with this development, the module will serve its purpose to the learning process in terms of reliability. Teaching strategies should be incorporated with reliability so that the activities that are to be given will really measure what they intend to measure in terms of the academic performance of the learners [19].

Module Content

The learning module involves selected topics for grades seven, eight, nine, and ten biology. Such topics include cells, microorganisms, digestive system, biodiversity, photosynthesis, and cellular respiration, as well as evolution and ecosystems. Criteria under this parameter are found in the table below rated with a scale of 1-4,
1 = POOR 2 = FAIR 3 = GOOD 4 = EXCELLENT

Rubric for Module Content

MODULE CONTENT	4	3	2	1
GRADE 7 BIOLOGY				
The module content involves sufficient information and data about the topic in relation to organelles and structures of plant and animal cells				
The microorganism section of the module incorporates essential information and activities as required by the curriculum guide				
GRADE 8 BIOLOGY				
The module content in relation to the structures and functions: Focus on the Digestive System provides the essential components needed as given in the curriculum guide				
The content about biodiversity provides all essential details needed by the students as required by the curriculum guide				
GRADE 9 BIOLOGY				
The module content involves essential components involved in photosynthesis and cellular respiration. The activity provides essential understanding to the importance and significance of photosynthesis and cellular respiration				
GRADE 10 BIOLOGY				
The module content in relation to evolution and ecosystem provides adequate and sufficient information in relation to species diversity, human activities, and occurrence of evolution				

Results of the Evaluation by the Validators in terms of the Module Topics

Validators	Value	Description
1	3.5	Excellent
2	3.9	Excellent
3	4	Excellent
4	3.0	Good
5	3.4	Excellent
6	4	Excellent
7	2.0	Fair
8	3.6	Excellent
9	3.4	Excellent
10	4	Excellent
11	3	Good
12	3.7	Excellent
Overall Mean	3.5	Excellent

The education system in the Philippines must be strengthened and further nurtured so as for the country to achieve all its targets and codes [20]. With this, recent developments and improvements were implemented in the Philippines such as the K to 12 curricula.

Project-Based Learning Content

Project-based learning methodology can give autonomy to learners on how to solve certain problems through making a project that will solve such problems. By making such projects, other skills such as problem-solving skills, leadership, teamwork, and even creativity can be improved as they go through each lesson through solving problems by accomplishing certain projects.The project-based learning content of the module is described by the validity of the PBL content, appropriateness of the project to the topic, and the suitability of the project to the learners. The table below shows the rubrics that were used by the module validators in rating the researcher-made module in terms of its project-based learning content.

Results of the evaluation by the Validators in terms of the Project-Based Learning Content

Validators	Value	Description
1	3.8	Excellent
2	3.7	Excellent
3	3.7	Excellent
4	3.0	Good
5	3.8	Excellent
6	4	Excellent
7	2.3	Fair
8	3.8	Excellent
9	3.3	Good
10	3.8	Excellent
11	3.3	Excellent
12	3.2	Good
Overall Mean	3.5	Excellent

With these values, the learning module is expected to provide the learners with an academic experience that involves project-based learning methodology. It is good to note that all the contents of the module target the creation of specific projects that will help the students in coming up with solutions to the problems that are presented in the researcher-made learning module. The implementation of project-based learning methodology focuses on activities in PBL methodologies that cohere with the curriculum requirements [19]. In addition, problems to be solved and projects to be made must be authentic and must be of use for our learners. Through the researcher-made learning module, the students are expected to not only learn the content of the lesson, but they are also expected to learn the value of developing critical thinking, problem solving, collaborative, and leadership skills [17].

Grammar and Plagiarism Test

Apart from the evaluations performed by the validators, the researcher also has input this paper through Grammarly.net, and Plagiarismchecker.net. This process ensured that the paper and the project-based learning module will be spared from grammatical errors and plagiarism. The result of the test done by Grammarly.net for the learning module is marked 84; it says that the text scores of the module are better than 84% of all texts checked by Grammarly.net. The result showed that the entire module has a reading time of thirty-two-minutes and thirty-two seconds, and one hour and two minutes of speaking time. For the plagiarismchecker.net, the result showed that the contents of the learning module are one hundred percent unique; thus, there are no notable areas in the module that is considered as plagiarized.

IV. CONCLUSION

This study has resulted into obtaining the mean for each category that described the learning module. It is good to note that generally, the module was marked excellent; hence the learning module would be able to serve its purpose since the essential elements of a good learning module are met. In addition, the researcher-made module also provided other relevant elements that could further enhance the academic experience by the learners. There are some areas in the learning module that received a mark of good and fair for the learning module; such areas include the content and the PBL nature of the module. With this, there could be some minor improvements that could be done to be able for such areas to be marked excellent.

V. RECOMMENDATION

From the findings and conclusion of this paper it is recommended that other researchers could make use of this module to test its effectivity through implementing the learning module to actual classroom setting. The future researcher can evaluate it in terms of its effectivity in improving the academic performance of the learners in the provided topic, and other related skills such as student leadership, creativity, critical

thinking, and problem-solving skills. Future researchers can revisit this learning module especially in areas that were not marked excellent. They could investigate it to further reinforce its existing characteristics so that such areas could eventually be marked excellent. In addition, they could look further into the activities, projects, and problems that were already given and provide other activities that could target specific skills such as creativity, leadership, and problem-solving skills. In this learning module, it focused on the least learned competencies in junior high school biology, other topics in Biology can be investigated.

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