UTILIZATION OF PROJECT-BASED LEARNING (PBL) RESOURCES IN SENIOR HIGH SCHOOL

[1]MARIEL L. RESABA. EdD., [2]NORRIE E. GAYETA, PhD.
[1]0000-0002-2285-8476,[2] 0000-0002-2965-8311
[1]mariel.resaba@deped.gov.ph, [2]norrie.gayeta@gbatstate-u.edu.ph
[1]Primitivo Kalaw Senior High School, Division of Batangas, Department of Education
[2]Batangas State University, Main I, CTE, Rizal Avenue, Batangas City, Philippines

ABSTRACT

This study assessed the utilization of project-based learning (PBL) resources in Senior High schools. It described the PBL resources and the extent of their utilization along science, technology, engineering, and mathematics (STEM) components. It compared the administrators' and teachers' assessment on the PBL resources. Further, it identified the opportunities and challenges in these resources. A management program was prepared to enhance the delivery of STEM instruction. This study used the descriptive method of research with a questionnaire as the main data gathering instrument. Unstructured interview and focus group discussion complemented the results. Respondents were 124 administrators and 304 STEM teachers from the four Division of Batangas – Division of Lipa, Batangas, Batangas City, and Tanauan. Weighted mean and t-test were used in the analysis of data. Project-based learning in public senior high schools was supported with capable teachers and sufficient material resources. The utilization of PBL resources Along Science, Technology, Engineering, and Mathematics was observable among STEM teachers, yet there was seeming need to use them more extensively for better Science instruction. On the other hand, the administrators and STEM teachers varied significantly in their assessments on adequacy of PBL material resources, but both concurred on human resources to handle PBL instruction and activities. Moreover, main concerns were financial resources and optimizing PBL resources for international collaboration and research appreciation. Finally, the developed management program for the utilization of PBL resources may provide administrators and teachers an appropriate framework to use PBL resources that enhance the delivery of STEM instruction.

Keywords: Project Based-Learning, PBL Resources, STEM Instruction, management program.

INTRODUCTION

STEM education integrates an understanding of science, math skills, and the technology with the ability to perform engineering design process. It is an interdisciplinary field that connects the four disciplines, namely Science, Technology, Engineering and Mathematics. Students who master STEM has a lot of capabilities, such as the ability to identify, implement, and integrate the concepts of Science, Technology, Engineering and Mathematics to understand complex issues and have the power to innovate in solving problems. Department of Education identified STEM strand had to be the second-most enrollment career path in Academic Track. Apart from the very fact that STEM strand gives you more options on what to select for your college courses, this data has also been proven by an increasing number of students who put interest in different STEM-related. field such as Agriculture, Engineering, Health, Information Technology, and other diverse courses in Mathematics and Science.

The continuing high attention for Science, Technology, Engineering and Mathematics (STEM) from students, teachers and curriculum developers was evident even before Department of Education (DepEd) mandated the revision of the

Philippine Education System through the Republic Act No. 10533 otherwise referred to as the "Enhanced Basic Education Act of 2013" (DO 43, s. 2013). This action of adding two additional years for Basic Education known to be the senior high school School's Grade 11 and 12, aims to supply graduates who are "globally competitive" with the acquired skills and competencies there is suited to local and international requirements specially with the continuous advancement in the field of STEM.

Meanwhile, Project-based learning is rooted in the progressive education movement, which advocated for more student- centered and experiential approaches that support deeper learning through active exploration of real-world problems and challenges. It is an effective pedagogical approach that produces quality content learning, higher levels of engagement and more positive perceptions of the subject matter (Bas, 2011). Hence, it challenges the students to demonstrate solutions to produce outcome which requires hands-on work that gives students the opportunity to develop the real-life skills required for success in today's world. Furthermore, it has been utilized for decades in a variety of content areas and in a variety of settings. It provides students with practical applications of concepts that allows for them to make connections between the content being learned and the real world. The connections allow students to see that there are opportunities for them to use information gathered in the real world (Efstratia, 2014; Chang, 2014).

The role of project-based learning (PBL) in STEM has gained much interest since the beginning of the 21st century. STEM PBL instruction is quite different from knowledge-centered and traditional instruction because it requires the teacher to fully comprehend its pedagogical orientation for successful teaching practice. Therefore, STEM PBL is both challenging and motivating. It requires students to think critically and analytically and enhances higher-order thinking skills. Also, it requires collaboration, peer communication, problem-solving, and self-directed learning while incorporating rigors for all students (Ejiwale, 2012; Capraro, 2013).

In addition, project-based learning presents students with a problem or challenge to solve, requires them to gather information from various resources, and asks them to come up with an original solution that ends in a product or performance (Railsback, 2012). It is an excellent approach that provides multiple options for students with different learning preferences and linguistic levels. Furthermore, project-based learning offers a wide range of benefits to both students and teachers. It uses in school to engage students, cut absenteeism, boost cooperative learning skills, and improve academic performance. Direct-instruction methods that rely on textbooks, lectures, and traditional assessments do not work well in the more open-ended, interdisciplinary world of project-based learning (Kean, & Kwe, 2013). Rather, teachers do more coaching and modelling and less telling. They need to be comfortable with wrong turns that students may make find easier way to complete a project. The central activities of a project involve inquiry and the construction of new knowledge by the student (Rabacal, Geroso, & Oliveros, 2018).

In connection to this, students are more likely to retain material and understand abstract concepts due to the more hands-on environment that project-based learning creates. Students learn how to collaborate and bounce ideas off each other so that it will develop their critical thinking and problem-solving skills and also allows them to learn different ways of thinking and how to come to conclusions more efficiently and effectively (Karaçalli & Korur, 2014). Students typically have a choice when it comes to designing their project, which allows them to pursue their interests and engage their curiosity. On the other hand, teachers may find themselves learning alongside their students as projects unfold. With ample project-based learning opportunities, students can succeed in multiple content areas in the classroom, along with skills that they can utilize to be successful. Moreover, it provides the contextualized and authentic experiences necessary for students to scaffold learning and build powerful science, technology, engineering, and mathematics concepts meaningfully (Lam, Cheng, & Choy, 2010; Capraro, 2013).

Undoubtedly, project-based learning is currently experiencing a resurgence of interest in K-12 schools based upon the need to ed 159 them in response to changes in requiring different

skills from the global workforce. It is not as a mere classroom instructional strategy, but as the means to redirect the instructional approach to teach the skills needed to prepare students for the modern global economy (Harris, 2014). Students become more engaged in learning when they have a chance to dig into complex, challenging, and sometimes even messy problems that closely resemble real life. Students' abilities to accumulate new understanding are enhanced once they are connected to meaningful problem-solving activities, and when students are helped to know why, when, and the way those facts and skills are relevant (Bell, 2010).

However, in orders to improve the performance of STEM student through project-based learning, teachers must have adequate resources and facilities that provide an atmosphere and amenities for student success (Tan, 2016). The school remains the vehicle upon which learning experiences that are relevant to the challenges of life are driven. It plays a key role in society by preparing future generations to use the acquired knowledge to fulfil their responsibilities more effectively. The school therefore must be a flexible, adaptable, and functional institution of the society (Lam, Cheng & Choy, 2010). Likewise, to achieve the efficient and effective teaching and learning process, it needs to harness and maximally utilize the material and human resources needed. Schools are incessantly procured new facilities like STEM laboratories, Research centers and e-classrooms for the scholars to enjoy a conducive learning environment. Department of Education is in n"art-28">skills and up-to-date approaches so as for them to perform their tasks and attain teaching targets. All these addresses the demand of global excellence in STEM education and respond to the call the acceptability of the revised Basic Education Curriculum to the Filipino community.

In this regard, the researcher, who is a Senior High School STEM Coordinator, intends to assess the utilization of project-based learning resources on STEM instruction in senior high schools in Batangas. This would serve as the basis to develop a management program in project-based learning resources that can be utilized for further improvement. As STEM coordinator for two years, the researcher experienced the challenges faced among the teachers who bring project-based learning into the classroom. Indeed, the researcher wants to take a risk in overcoming the initial challenges by proposing a management program for project-based learning (PBL) resources that might help to enhance the delivery of STEM instruction. The researcher believes that utilizing project-based learning resources to STEM learning can help teachers and students to communicate in deeper understanding to the key concept as well as on the mastery of 21st century essential STEM learning skills.

OBJECTIVES OF THE STUDY

This study assessed the utilization of project-based learning (PBL) resources in senior high schools in the province of Batangas.
Specifically, the study addressed the following objectives:

1. Describe the PBL resources as assessed by administrators and teachers
   1.1 Human
   1.2 Material
2. Determine the extent of utilization of STEM teachers on PBL resources along the following components:
   2.1 science
   2.2 technology
   2.3 engineering
   2.4 mathematics
3. Find out the differences between the assessments by the two groups of respondents on learning resources
4. Identify the opportunities and challenges in using PBL resources
5. Propose a management program on the utilization of the PBL resources.

METHODOLOGY

The study employed the descriptive research design and use a questionnaire as main data gathering tool. The questionnaire had three parts. Part I investigated the description of PBL in terms of human and material resources as assessed by the two respondent-groups. Part II

dealt with the extent of utilization of PBL resources along STEM components. Lastly, Part III covered the opportunities and challenges encountered in using PBL resources.

The procedure was systematically and orderly undertaken until the instrument was finally validated by the Dean of the CTE Graduate program and approved for administration. The questionnaires were personally administered by the researcher to each of the respondents in participating schools through the help of the STEM coordinators of the participating schools, friends, and teacher-colleagues. Retrieval of the answered questionnaire was also personally done by the researcher from STEM coordinators a week after the distribution.

Respondents of the study were 124 administrators and 172 STEM teachers selected using stratified random sampling with proportionate allocation. Statistical tools used to analyze data gathered were weighted mean and t-test.

RESULTS AND DISCUSSION

After a careful and thorough analysis of the gathered data, the study yielded these salient findings:

1. Description of PBL Resources

1.1 Human. Administrators strongly agreed that STEM teachers had the ability to use appropriate teaching and learning resources, including ICT to facilitate the research process in project-based learning. They are knowledgeable in selecting suitable instructional materials particularly in the use of technology-oriented materials that facilitate research process. This maybe because of the ICT-related trainings provided by the Department of Education. They added that the use of ICT resources facilitates the teaching and learning process in STEM lessons.

On the other hand, STEM teachers strongly agreed that they possessed mathematical skills needed in analyzing data and interpreting results. It implies that the teachers of PBL demonstrated mathematical knowledge and skill that warrants confidence in the use of mathematics. In this way, the teachers can promote strategies such as analyzing data, drawing contrasts, and making connections.

Composite mean revealed that the respondents agreed on the description of the project-based learning related to human resources.

1.2. Material. In the area of library and online resources, both respondents assessed that there was very adequate blog site that allowed students to share their work process. This implies that teachers utilized blogging to promote discussion among students. It promotes autonomous learning by providing opportunities students to take more control of their learning and encourages teachers' critical thinking that value and respect towards students' points of view.

In the area of classroom and laboratory facilities, for administrators, there were very adequate spaces to support collaborative work and demonstration table for experimentation. Collaborative learning spaces empower students to work with each other in multiple perspectives. Relative to teachers' assessment, it was revealed that there were adequate spaces to support collaborative work, and laboratory counter and storage room to ensure safe keeping of chemicals. This implies that teachers considered learning spaces for students offered high-quality collaborative learning experiences. It is also vital that invested properly for spaces in classroom must ensure that the students receive a maximum benefit by giving them the greatest chance of significant and measurable academic progress.

Composite mean indicated that there was an adequate library and online resources and classroom and laboratory facilities for project-based learning implementation.

2. Extent of Utilization of Project-Based Learning

2.1. Science. Designing a representation or simulation for a depth understanding of science concepts and integrating theory through practical work were the PBL activities that were utilized by the teachers to a great extent. Results imply that teachers consistently created an opportunity that challenged students and promoted inquiry by

designing a representation or simulation. Further, teachers are aware that they are responsible for designing and implementing the need to enhance their skills and abilities in teaching science.

On the other hand, preparation of simple experimental set-up to demonstrate science processes and visitation of industries or chemistry laboratory to gain tangible learning was utilized to a moderate extent. These results imply that outdoor activities were not fully implemented by the school. This is because the school followed the memorandum of Department of Education on educational tour for security of the students. However, industrial visits represent important activities that contribute to the achievement of various essential learning outcomes and objectives. It provides the students and programs with dynamic real time feedback that is very useful in the program learning outcomes process. It enables educational institutions to build close ties with industrial experts and to achieve the learning outcomes to students.

Composite mean indicated that PBL along science was utilized to a moderate extent in the Senior High schools in Batangas.

2.2. Technology. Creating original or derivative ICT content for image manipulation and graphic design and creating online environment to disseminate research findings were the PBL activities utilized by the STEM teachers to a moderate extent. This can be inferred that the teachers of PBL taught and provided the basic information skills, such as the use of various sources of computer materials and application of different computer software. As revealed by the science teachers in the conducted interviews, they need access to ICT improvements for classroom implementation and to keep up with continuous technological advances that is regular, scaffolded, and sustainable.

Overall, as evident by composite mean, STEM teachers moderately utilized technology associated PBL. It could mean lack of teachers' exposure in the use of modern ICT applications. These applications were not discussed to them in their undergraduate courses. Only basic ICT applications were introduced to them by their computer professors. In addition, as revealed in the FGD conducted, this applies more to senior teachers in the 50 above age bracket who are not trained to use ICT applications and software.

Engineering. Formulating appropriate mathematical statements using mathematical induction or binomial theorem and solving real-life problems accurately involving continuity of functions were utilized to a moderate extent by the STEM teachers. The moderate utilization of these PBL activities is maybe because teachers encountered difficulty in identifying mathematics content in a range of context and applications. Likewise, some of them need to understand how students develop understanding of specific mathematical content and how the content can be represented and made accessible for students. Understanding the knowledge required is vital given established importance to the effectiveness of PBL.

The composite mean indicated that the PBL as applied in engineering was utilized to a moderate extent and therefore needs to be included in the reform necessary for the enhancement of engineering instruction.

2.4 Mathematics. Performing appropriate tests of hypotheses and investigating problems involving simple and compound interests and simple and general annuities using appropriate business and financial instruments were utilized by the STEM teachers to a moderate extent. These imply that teachers in PBL had have a moderate understanding in those competencies in Mathematics. This was further confirmed by the teacher during the FGD. According to them, most of the topic in STEM such as Macromolecular Synthesis, Energy Metabolism, Molecular Genetics, Introduction to Computational Modeling Data Analysis, Statistical Analysis, Symbolic Math, Linear Algebra, And Simulation Techniques were not commonly discussed in high school. Therefore, this finding suggests that teachers should be given training on those areas.

The composite mean indicates that the PBL in mathematics was moderately utilized. Findings reveal that STEM teachers should be provided with the resources and trainings to learn new

mathematical skills needed to further improve the use of PBL.

3. Comparison on the Assessments on Project – Based Learning Resources

The two groups of respondents did not differ significantly in their assessments on PBL relative to human resources as revealed in the obtained computed t – value and yielded value, which is greater than 0.05 level of significance. This means both groups considered instructional supervision as part of their responsibility. They were both focused on providing guidance, improving performance, and enhancing professionalism, and morale of their teachers. Further, since they worked in same division, they were aware of the academic status and achievement of their co-workers and conduct regular observation. It also showed administrators tried to make teachers more efficient, so that they better develop students.

Table 9
Comparison on the Assessments on PBL Resources

		Mean	Std Dev	*T- value*	*P-value*	Decision on H_0	Interpretatic
Human Resources	Administrator	3.12	0.10	0.1979 -	0.4216	Failed to Reject	Not Significant
	Teachers	3.12	0.18				
Material Resources	Administrator	3.05	0.18	2.8525	0.0048	Reject	Significant
	Teachers	3.15	0.14				

α = 0.05

On the other hand, assessments different significantly on PBL relative to material resource as reflected in the computed t – value and yielded a value which was significantly lower than 0.05 level of significance. The mean report also shows that the STEM teachers assessed PBL material resources higher than the administrators. This could be because STEM teachers have first-hand knowledge in the utilization of project-based learning material resources than administrators. They were more aware on the adequacy, availability, and accessibility of the resources. They are the one that find time seeking information from different sources to be provided to their students. The findings were affirmed by the teachers on the conducted interview that student's performance was affected by the quality and quantity of teaching and learning materials.

4. Opportunities and Challenges Met in using Project-based Learning Resources

Respondents strongly agreed that project-based learning offered opportunities in the adoption of new learning models necessary for global collaboration and communications. Moreover, they agreed that the use of project-based learning will help students to develop appreciation for research in the field of science, technology, engineering, and mathematics resources. In using PBL resources, a student connects new information to the most crucial things to understand and remember in doing a certain project. It can also be inferred those students were able to acquire basic knowledge and skills on the projects and use them for learning purposes. Respondents were expected to expose students to a wide range of skills and competencies that may leads to innovation.

The composite mean indicates that the two groups of respondents concerned that there is an opportunity in using project-based learning resources.

On the other hand, respondents strongly agreed that sufficiency of funds to support project-based learning resources as well as the heavy and demanding workloads for teachers and students was a challenge encountered in using PBL resources. This means that in using PBL resources, it may result to additional workloads for teachers and students. This maybe because since there are insufficient resources, teachers are required to fund alternative ways. to pursue PBL. Likewise, students will consume over time to finish the project created by their teacher. This was supported by the teachers from the conducted interview that since PBL was new to them, they need time to reflect on their work, plan lessons, develop skills and knowledge, and interact with colleagues about the approach.

The composite means indicate agreement of the two groups of respondents on the challenges in project-based learning resources utilization. This is because respondents are both involved in

planning, organizing, and implementing PBL and were knowledgeable on the requirement to successfully implement PBL.

5. Development of Management Program for Project-based Learning (PBL) Resources

Based on the key results of the study, a management program was proposed to manage the utilization of PBL resources. It features objectives, timeframes, activities/projects, and expected success indicators. Specifically, it highlighted different activities that may serve as a guide in the implementation of PBL resources management programs for the enhancement of STEM instruction.

CONCLUSIONS

In the light of the findings revealed by the study, the following conclusions are drawn:

1. PBL in public Senior High schools is supported with capable STEM teachers and sufficient material resources.
2. While the utilization of PBL resources along Science, Technology, Engineering, And Mathematics is observable among STEM teachers, there is still seeming need to use them more extensively for better science instruction.
3. The administrators and STEM teachers vary significantly in their assessments on adequacy of PBL material resources while similarity in assessments exist in human resources capability to handle PBL instruction and activities.
4. Sufficiency of funds to support project-based learning and optimizing PBL resources for international collaboration and research appreciation are the main concern for PBL implementation.
5. The developed management program for the utilization of PBL resources may provide administrators and teachers appropriate framework to use PBL resources that enhance the delivery of STEM instruction.

RECOMMENDATIONS

Based on the foregoing findings and conclusions, the following recommendations were presented:

1. The proposed management program may be evaluated and validated for the possibility of its implementation for STEM instruction.
2. Collaboration with stakeholders may be strengthened for possible human and financial support in the conduct of different PBL projects and programs.
3. A similar study may be conducted for the continuous enhancement of STEM instruction.

REFERENCES

Bas, G., (2011). Investigating the effect of PBL on students' academic achievement and attitudes towards English lesson. *The Online Journal of New Horizons in Education*, 1 (4) Retrieved from https://www.tojned.net/journals/tojned/articles/v01i04/v01i04-01.pdf

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *Clearing House: A Journal of Educational Strategies*, issue 2, vol 83 pp 39-43 https://www.tandfonline.com/doi/abs/10.1080/00098650903505415

Capraro, M. M., (2013). Interdisciplinary STEM project-based learning. *The Netherlands. Sense.* https://www.springer.com/gp/book/9789462091436

Chang, W., (2014). Group communication and interaction in project-based learning: The Use of Facebook in a Taiwanese EFL Context. *International journal of Learning, teaching and educational research Vol. 1, No. 1, pp 108-130.* https://www.ijlter.org/index.php/ijlter/article/view/6

Efstratia, D., (2014). Experiential education through project-based learning. http://dx.doi.org/10.1016/j.sbspro.2014.09.362

Ejiwale, James A. (2012). Facilitating teaching and learning across STEM fields. *Journal of STEM Education: Innovations and Research.*

https://eric.ed.gov/?id=EJ988078

Harris, M. J. (2014). The challenges of implementing Project-Based Learning in middle schools. *ProQuest Digital Dissertations. (1666828757)* http://dscholarship.pitt.edu/23533/1/MatthewJHarris Dissertation%235.pdf

Implementing Rules and regulations of the enhanced basic education act of 2013, (Republic Act No. 10533). https://www.officialgazette.gov.ph/2013/09/04/irr-republic-act-no-10533/

Karacalli, S., Korur, F., (2014), The Effects of project-based learning on students' academic achievement, attitude, and retention of knowledge: The subject of "electricity in our lives. https://onlinelibrary.wiley.com/doi/abs/10.1111/ssm.12071

Kean Ang, C., Kwe, N., (2013). Meaningful learning in the teaching of culture: The project based learning approach. *Journal of Education and Training Studies 2(2).*https://www.researchgate.net/journal/Journal-of-Education-and-Training-Studies-2324-8068

Lam, S.-F., Cheng, R. W.-y., & Choy, H. C. (2010). School support and teacher motivation to implement project-based learning. *Learning and Instruction, 20(6), 487-497.* https://psycnet.apa.org/doi/10.1016/j.learninstruc.2009.07.003

Rabacal, J. S., Geroso, M. S. & Oliveros, J. A., (2018). Developing students' 21st century skills using project-based learning. *Asia Pacific Journal of Multidisciplinary Research, Vol. 6, No. 2, 47-53.* http://www.apjmr.com/wp content/uploads/2018/06/APJMR-2018.6.2.2.06.pdf

Railsback, S.,Grimm, V., (2012) agent-based and individual-based modeling: A practical introduction. https://www.researchgate.net/publication/258260755_Agent-Based_and_Individual-Based_Modeling_A_Practical_Introduction

Tan, J. Chapman, A. (2016). Project-Based Learning for academically- able students. *Sense Publishers*. https://www.springer.com/gp/book/9789463007320

AUTHORS' PROFILE

Mariel L. Resaba, Ed.D is designated as master teacher 1 at Primitivo Kalaw Senior High School and a part-time Instructor at University of Batangas, Lipa Campus, taught science subjects. She is a STEM coordinator and School Based Management Coordinator. She obtained BSED-General Science degrees at Southern Luzon State University in 2005. She earned her master's degree major in Science teaching and Doctor of Education major in Educational Management at Batangas State University, Main I, Rizal Avenue, Batangas City in 2015 and 2020, respectively.

Norrie E. Gayeta, Ph.D obtained the BSEd-General Science and MAEd-Science Teaching degrees at Batangas State University in 1997 and 2001, respectively. She finished her Doctor of Philosophy in Science Education at Centro Escolar University in the year 2017. She taught Chemistry subjects at Public Secondary School for 10 years and 15 years at Batangas State University. At present, she is a science professor of the Batangas State University, College of Teacher Education, Undergraduate and Graduate programs. She also served as Department Chairs and Associate Dean of the said College. Currently, she is the Head of Quality Assurance Management of the same University.

COPYRIGHTS

Copyright of this article is retained by the author/s, with first publication rights granted to IIMRJ. This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution – Noncommercial 4.0 International License (http://creativecommons.org/licenses/by/4).