ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 11, Issue, 07, pp.5656-5663, July, 2019

DOI: https://doi.org/10.24941/ijcr.35863.07.2019

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

PROJECT-BASED LEARNING (PBL) IN TEACHING CHEMISTRY

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ARTICLE INFO

Article History:
Received 16th April, 2019
Received in revised form
10th May, 2019
Accepted 12th June, 2019
Published online 31st July, 2019

Key Words:

Project-Based Learning,
Chemistry,
Redox Reaction

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ABSTRACT

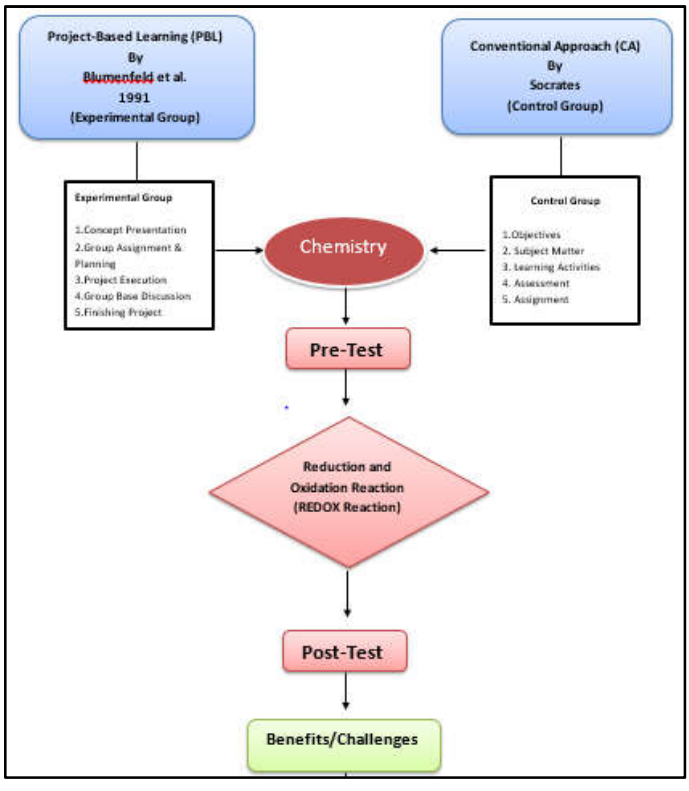
Vital to Project-Based Learning (PBL) approach is the emphasis that leaning is most effective when learners put theory into practice. This research established what PBL approach in teaching Chemistry can contribute in learner's skills and competencies and determined the benefits and challenges in the utilization of PBL. This is an experimental research which utilized the Quasi-experimental research design specifically the Non-equivalent Control Group Design with Pretest and Posttest. There were twenty-five (25) research respondents in experimental group and twenty-five (25) research respondents in the control group. The experimental group was exposed to project-based learning method while the control group was exposed to conventional approach. The reliability and validated – tested pretest were given prior to their exposure to PBL and conventional Approach methods. Posttest was administered after the instructional interference. The data collected from the pretest and posttest performance were analyzed using the mean, t-test, and z-test. Based on the results of the pre-test and post-test of Conventional Approach and PBL groups, a significant difference exists between the academic performance of learners exposed to each group, in favor to Project-based learning group. According to the interview conducted by the researcher, the evident challenges for both learners and teacher were the Clarity of Instruction, Focus of the students to learn, Time Management, Knowledge of Technology Used, Facilitative Skills; and the benefits were: Collaborative Learning with the students, Social participation, Strengthen the bond between students, Critical Thinking Skills. As discovered in the findings of the study, Project-Based Learning is an effective teaching strategy that can be utilized in teaching chemistry to enhance the performance of the learners when it comes to academic.

Citation: Randy Delostrico, **2019.** "Project-Based Learning (PBL) in Teaching Chemistry", *International Journal of Current Research*, 11, (07), 5656-5663

INTRODUCTION

The K-12 Basic Education Program in the Philippines requires the institution and educators to help learners today build important lifelong skills in order for them to succeed in this more innovative period. It is important to note from the historical basis that the early evidence of experiential education found from the conventional methods of teaching of Socrates who first applied the inquiry-based approach in teaching (Chester, 2012). The question of whether traditional teaching methods are effectively preparing the learners for their future. In present time the learners are expected to score high on a narrow set of standardized exams. Unfortunately, this kind of exams leaves a little room for higher order thinking skills. Some believed that project-based learning has the potential to give the learners the opportunity to develop their higher order thinking skills in a range of diverse areas while implementing subject content. Learning through experience is one of the key aspects of obtaining information. Efstratia (2014) sated that PBL is a modern method of teaching, that the main idea is to connect learner's experience with school and personal life and to have an analytical skill as learners acquire new knowledge. Though there are negative inference linked to PBL, this method of teaching can be beneficial to the modern teaching approaches if implemented correctly. Through PBL's experiential learning approach, real world problems of the learners are accomplished. Based from the results of the National Achievement Test (NAT) given to public institutions in Cebu City, obvious results of 53% and 57% in Science were evident for the past few years (Ilayon, 2014). These results obviously didn't meet the basic standard performance of 75%, which signifies that the result failed also in achieving international standards. In addition, TIMMS (2008) showed that even schools which are recognized to be the finest with most brilliant students being enrolled did badly in the exam. These researches indicate that several actions must be done to raise the level of learners' performance. Consequently, the researcher conducted this study in order to raise the proficiency and elevate the quality of education in instructional science. This study anchored with Project-Based Learning aims to carry out in the high school level, comparing with conventional teaching method. To support the study, the researcher creates lesson plans aligned to Project-based learning and conventional teaching method which is the basis for the Chemistry exam of the topic Reduction Oxidation Reaction (REDOX Reaction) that serve as pre-test and post-

test to the respondent. The academic performance of learners is compared with the conventional teaching method using the pre-test and post-test results. The educator act as the facilitator in preparing the extensive notes for he leaners since they are new to the learning approach. Many educators are developing a new type of programs, with the objective of increasing the engagement of learners and helping them develop deeper knowledge of essential ideas. Project-Based Learning permits learners to comprehend by doing and applying ideas. Learners involve in real life activities that are similar to the activities engage by professional adults. (Krajcik *et al.,* 1994; Blumenfeld *et al.,* 2000). Efstratia (2014) noted that the main idea of Project-based learning is to capture students' interest in a practical problem and apply new knowledge in a problem-solving situation. The educator serves as the facilitator, working with students to emphasize valuable queries, organizing meaningful activities, coaching social skills, and keenly assessing what learners have learned from the activities (David, 2008). Project-based classroom gives students the freedom to investigate questions, propose hypothesis and explanation, discuss ideas, contest and test the idea of others, and try to produce original ideas. (Marx *et al.,* 2004; Rivet and Krajcik, 2004). The origins of Project-based learning range back from hundred years, to the educator and philosopher John Dewey (1959), whose teaching approach was based on inquiry. He argued that learners will develop personal interest in the classroom if they engage in real, meaningful task and problems that emulate practical situations (Solomon, 2003; Staff, 2001; Willie, 2001). The roots conventional teaching method spread back over a 470 B.C, to the work of Athenian philosopher Socrates (Knezic, *et al.,* 2010). Socrates planned to make each individual a masters of his own mind and being state. Lam (2011) stated that utilizing Socrates method in teaching such as giving queries and not answering, teachers simply force learners' intellect and rational relationship of their previous knowledge and experience. Since critical thinking skills cannot be directly taught by the conventional methods, it can be engaged and cultured and learners are nurtured to improve these skills.



The conventional teaching of chemistry is anchored on the Socratic teaching methods which aims to engage students in lecture by enquiry that needs generative answers from the learners. Technically, the answers to the questions are not the endpoint for ideas but instead a starting point for further understanding of the topic. This approach is imposed by the teacher by asking questions to the learner in a way that requires the students to analyze and justify their answers to the questions. Ilayon (2014) explain that it is important for the educators to give clarity to these questions that its aim is not to create judgment to the environment, but rather to help learners examine their attitudes, beliefs, and knowledge. Teachers, governments, and scholars from different countries are currently considering the PBL to be one of the main innovative approaches to science and technology in k-12 schools (Fallik *et al.,* 2008; Krajcik *et al.,* 2008). The implementation of project-based learning in elementary education in Hong Kong, makes the change visible in teacher education as well as the general philosophy in educating the young children (Li, 2012). The views of project-based learning among the teachers were very significant, the impression of learners working collaboratively with the engaging projects which are authentic made sense to them. While this was the circumstance, research data indicated that implementation of project-based learning was a challenge to the teacher. Educators commonly giving up unfamiliar teaching approach and many of the projects were driven by the teacher from the systematic lesson plans, instead of students centered project. The general agreement sated by Li (2012) was that educators were enthusiastic about the vision of change that project-based learning can do, and give their best to plan, prepare for the materials and etc. Project-based learning has always been an essential part of the curriculum among the various educational institutions in the Philippines, it is consistently combined across the curriculum as early as elementary. Thus, the educational system aims to prepare Filipinos with skills intended for them to address the real-world concerns and make them a desirable worker (Tiangco, 2005). Projects have continuously contributed a substantial part in the growth of Science and Technology among the Filipinos. In the early phase of education, students learning Science are already exposed to innovative projects such as Science Investigatory Projects. This study aims to help the educators in providing new ideas in teaching and, guide chemistry teacher who request to implement Project-based learning to raise learner's academic performance. The outcomes would also guide the Institutions, teachers, and learners to give emphasis on PBL for the improvement of learners' academic performance.

Review of Related Literature and Studies

Related Literature

Article III, Section 1 of the Code of Ethics of Professional Teacher which states that "a teacher is a facilitator of learning and the development of the youth; he shall, therefore, render the best service by providing an environment conducive to such learning and growth". Worldwide organizations give importance to human resources nowadays. These are individuals that manipulates machines and provide the need of every consumer in the society. According to Tadifa (2015), In order to utilize human resources effectively, they should be furnished with skills that can be acquired through education. As stated by Vinluan (2007), science education is one way to produce globally competitive individuals and uplifting the

living conditions of every person in the country. Fox (2013) states that the implementation of reform for education in today's culture are common. The use of constructivist approaches holds a significant increase for the learner's motivation towards the subject and success towards the skills. Project-based learning is one of the most substantial approach under the umbrella of constructivist learning method. It shows that if PBL will be implemented carefully, the students will engage more from the subject, motivation will increase, and helps students build a fundamental knowledge of the content. Collaboration between the schools and the teachers towards effective implementation of the PBL is very essential to create a well-structured program that aims to increase the skills of the student's interims of problem solving, social collaboration skills towards other learners and the skills to apply student's learning to everyday life circumstances. New abilities are expected to prevail in the worldwide workforce, due to expanded globalization and developments in innovation. Rabacal *et al.* (2018) it is vital for schools to make pressing move to stay aware of the new demands. As in all changes, education will assume a critical part in setting up the coming age of laborers. However, the nature of the present training in the Philippines misses the mark in giving the students the essential skills, since education frameworks are generally centered on preparing students for standardized testing, yet with an absence of research, an absence of utilization of the learning. The Department of Education had boarded into a new basic education reform – the K to 12. This reform includes enhancing the basic education curriculum, lengthening the cycle of basic education to cover kindergarten through year 12. The K to 12 Curriculum considers every aspect of the development of the learners so that graduates will acquire true mastery of basic competencies to better prepare them for employment, entrepreneurship, middle level skills or higher education.

Project-based learning is seen as an approach that empowers students to build up the 21st century capabilities - psychological and socio emotional abilities - required for progress (Quint *et al.,* 2018). According to Boss (2012), educators have long seen and understood the value of projects to help students learn new concepts. Karaman *et al.,* (2008) describe Project-Based Learning (PBL) as a model that organizes learning around projects. Learners decide how to approach a problem and what activities to pursue. They gather information from variety of sources and synthesize, analyze and derive knowledge from it. Their learning is inherently valuable because it is connected to something real and involves adult skills such as collaboration and reflection. In the end, students show their newly acquired knowledge and are judged by how much they have learned and how well they communicate it.

Tadifa (2015) states that government is giving attention to the field of Science and Technology. The Philippine Constitution of 1987 mandates that the government should give a full sustenance to researches and projects that geared towards the development of Science and Technology. Moreover, Luistro (2015), the realities of the modern world require a different kind of Filipino. The Filipino must be a lifelong learner, holistically developed, globally oriented and locally grounded. The modern Filipino must possess the skills and vision applicable in the 21st Century. The K to 12 Curriculum is focused on the learner's acquisition of the 21st century skills, Department of Education. These skills include: learning and innovation skills; information, media, and technology skills; effective communication skills; and life and career skills. These skills are needed by the students to be successful in the 21st century workforce, Partnership for 21st Century Skills. Fernandez (2002) mentioned that the most Philippine families give more importance on education since they believe that it is a way to change the better lifestyle of their children in the future. Education give the vital role in attaining the vision of an individual, this is the reason why education institution in the Philippines continually upgrades the quality of education. The National Science Teachers Association (NSTA) endorses that science teachers need to provide instructional materials with a priority on making observations and evidence as much as the learners experience in the field, to help them develop a deeper understanding of science content, attitude of a scientist and the skills of a scientific reasoning (NRC,2005). Innovative science instruction should supply students with choices to explore as well as engage in steps which would assist them in exploring their world. Effective learners are those who are actively involved in the learning process, understand the values of learning and admit responsibility for their education throughout the experience (Ilaya, 2015).

Studies of PBL: Several studies and researches point out the use of Project-Based Learning in teaching pedagogy and learning process, yet these reports focus less on the proper execution steps for PBL and the assessment of topics in terms of its effect to the learners towards the area of science with the emphases on chemistry. Ross *et al.* (2004) stated that some studies give a clear structure in implementing PBL as an approach in teaching. However, the absence of a widely accepted framework or theory of PBL upon which teachers and researcher might be basing (Thomas, 2000).

Project-Based Learning is not just effective in increasing the academic achievement of the students but also improving students' attitude and motivation towards learning (Altun Yancin, *et al.,* 2009; Chiang *and* Lee, 2016; Erdem, 2012). Condliffe (2016) mentioned that PBL research improve learners' problem solving and critical thinking skills. Learners who have difficulty in traditional way of teaching instruction have frequently been found to do good in academics when they introduce with PBL in the class. Most of the study on PBL are in the K-12 setting which strongly suggest the effective approach in the k-12 program in the country. In the study of Cakici *et al.* (2013) on the effect of project-based approach on learners' achievement and attitude in the subject science in Northern western park of Turkey. The students were divided into the control group and experimental group who underwent the intervention using project-based learning strategies. During the implementation of the project-based learning, the researcher keenly observed all the learners on how they made their projects. The result of the study shows a significant difference in terms of achievement in science as a result of making the learning process more meaningful to the learners. Yet, there was no significant differences on the attitude towards science. The researchers explain that the possible reason is that the students experience a difficulties during the project making activities. Similar study conducted by Khaliq (2015) in one of the federal government high school. They found out that the learners who underwent the treatment PBL performed better than the control group. Thus, Project-based learning techniques was found to be more effective in teaching science because it stimulates the natural curiosity of the learners to explore. Yancin, *et al.* (2009) investigated the effect

of project based learning on the first year science undergraduates' attitudes towards physics, electricity achievement, and the development of scientific process skills. The participants were 90 first year science undergraduate students from Science Teacher Training Department in Bayburt Education Faculty in Turkey. Pretests and post tests were given to both experimental and control group. The unit about electricity was taught using the project based learning approach to the experimental group while a more traditional teacher-centered approach was used in the control group. It was found that the achievement scores in the unit about electricity of the experimental group was statistically significantly higher than the control group. It was also found that the scores of the experimental group with respect to their scientific process skills and attitude were higher than the control group. The researchers 20 interviewed five students from the experimental group and asked things that served as reasons for them to score higher in the post test. The results of the interview revealed that students gained confidence in their own learning and initiative to discover knowledge and skills needed to accomplish the project with the help of the driving question at the beginning of the unit. Difficulties such as time on task, division of labor and finding funds for the project were common among the interviewees because project based learning approach was new to them

Mayer (2016) investigated the students' perceptions of life skill development in project-based learning schools. The results show that students' perception on time management, collaboration, communication, and self-directedness drastically improved. The study revealed that the students' perception of their life skills improved through the implementation of Project-Based Learning approach. A study conducted by Redmond (2014) reports that project-based learning improves the academic achievement of the students through collaboration, active participation, and meaningful projects. The primary focus of the research is academic achievement which resulted in data collection surrounding the research question, "How does project-based learning impact student achievement?". Redmond (2014) used two sections of fourth grade science. Each section underwent a treatment phase and no treatment phase. The score that was used in the statistical analysis were generated from the Northwest Evaluation Association Measures of Academic Progress NWEA MAP test. The results of the statistical analysis revealed that after the treatment phase the students scored in the test significantly higher than the non-treatment phase. nThe data from Redmond (2014) is very helpful in identifying the key on how teachers can intensify project-based learning in the classroom. According to Redmond (2014) it is imperative for the teachers to build the plan and implement project-based learning at the beginning of the school year and make it as another classroom routine where the students know how to participate in. In that way the process of collaboration and research will become spontaneous to the students.

RESEARCH METHODOLOGY

If you have a Table, simply paste it in the box provided below and adjust the table or the box. If you adjust the box, you can keep the table in single column, if you have long table.

Research Design: The study use pre-test and post-test scheme involving two groups: one an experimental group well be given an experimental treatment – the PBL approach, while the control group well be given no treatment over the same period of time – the conventional approach. Consequently, the researcher uses an experimental study. Both groups will undergo the same academic achievement test in chemistry as a pre-test prior to the experimental process to determine the group's performance level. For the meantime, the academic achievement test was employed as a post-test and administered to both groups after the experimental process to determine the effect of the treatment.

Research subject and respondents: The subject of the study consisted of all 50 grade 10 all boys' students with mean age of 16 years old in two classes selected from a private school in Lahug, the PAREF Springdale School Inc., Cebu City Division for school year 2018-2019. The students involved were of the same level. Out of the sample, one group (G1) was randomly assigned to the experimental group (n=25), while the other (G2) formed the control group (n=25) of the study. All the students in the groups will take the pre-test and compared with post-test to determine their academic achievement and performance

Table 1. The Distribution of Respondents

Sex	(G1) Experimental Group	(G2) Control Group	Total
Male	25	25	50

Research environment: The study conducted at PAREF Springdale School Inc. Cebu City, where the researcher is currently teaching. PAREF Springdale School Inc. is a private single-gender basic education institution located on J. Solon Street in Lahug, Cebu City, Philippines.

Research instrument: The researcher uses a researcher-made questionnaire as a tool to gather the data. The input was adopted from different chemistry reading resources, and DepEd K-12 Science Curriculum as the bases in making the questionnaire. The questionnaire prepared by the researcher was only coved by the topic Redox Reaction for two groups, the experimental and the control group. A total of 50 items in a multiple-choice format with TOS will be us. The items will be content validated by the PAREF Springdale Science Coordinator and the Kudar-Richardson Formula 20 based on the objectives intended for the topics. The items were adapted to fit the processes that occurred in the PBL and lectures on the topic.

Data-Gathering Procedure: The researcher requested his science coordinator with TOS to evaluate the instruments in terms of validity, reliability and with the help of Kudar-Richardson Formula 20, Item relevance and clarity and understandability of the directions. The researcher will seek for approval to the School Principal through a letter, and personally administered the instruments to the respondents. At the start of the topic in chemistry, the researcher will administer the pre-test first. Both the experimental and control groups answered the pretest. The PBL will be implemented by first giving the advance organizer about the topic that will be covered and the objectives to be learned. The students in the control group only received conventional teaching focuses on the topic by lecture. While the experimental group both the lecture and the Project-Based Learning activity, the post-test for PBL and conventional teaching will then be administered. The concepts will be explained to the learners through lecture

and detailed instructions for the project given to them. In the development of project, the learners will be divided into micro groups and given a task to propose a plan to provide the evidence through an experiment. The students will be given feedback and suggestions from other groups and proceed in doing the task. They present their final work in class as the final part of the Project-Base Learning. The following are the details of each part:

Part 1: Concept Presentation – The teacher introduces the topic in advance organizer then present the subtopics of the different concepts in a framework form. The students then provide proof in investigating the concept through facilitative process by asking questions given by the teacher.

Part 2: Group Assignment and planning – The experimental group will be divided into micro groups to work on a project. The teacher will give instruction to the group that they tasked to come up with an experiment or study to provide evidence on the given concepts about redox reaction. The group brainstorm and come up with a framework of the actual project calendar accomplish by the group, where they include the objective, members, material use, and procedure. As an assignment, the learners will look for related references that explain the topic to expand their knowledge.

Part 3: Project Discussion and Feedback – The plan of the micro group will be presented to the class and provide their critiques, feedbacks and suggestions to improve the project to be develop. The micro group then make the revision of their work after the feedback.

Part 4: Project Execution – The learners carried out their plan in investigating the phenomenon through observations, data recording, and making general conclusions for their final reports.

Part 5: Group Base Discussion – The result of the project will be presented in class. The data gathered from the project execution will serve as an evidence that will explain the occurrence of the phenomenon investigated. The other micro group will raise a questions, issues and critiques about the results. The group presentation will be evaluated using a rubric.

Part 6: Finishing Project - The learners will write a narrative report of the entire procedure, the project model, and the project result.

Data Analysis and Procedure: The analysis aims to show the difference in the students' level of learning of the control and experimental groups. In this study, Statistical techniques such as mean, Standard Deviation (SD), Z-test, and T-test were used to determine the significant difference between the pre-test and post-test mean scores of the two groups (PBL and Conventional Approach) in teaching chemistry.

RESULTS AND DISCUSSION

This section presents the answer to the research questions and also the data gathered from the different sources specifically through the student's achievements on a research-based exam and projects created throughout the study. The data collected from the study had been tabulated and statistically tested for objective interpretation of the pre-posttest performance of students exposed to Project-Based Learning and Conventional Approach in teaching. The substantial improvement in the academic performance of learners exposed to both groups were analyzed, and also the challenges and benefits of using PBL and conventional approach in teaching were enumerated.

Pre-Posttest Performance of the students in chemistry: The comparison of pre-posttest results of the learners in the control and experimental groups. The z-test was employed in order to determine whether their performance fell under: below average (<-1.96); Average (between -1.96 to 1.96); or above average (>1.96) with respect to their pre-knowledge and understanding of concepts in the selected lessons of the unit. It also shows the comparison of the actual means of the two groups in the pre-test. In this case, the p-value standard is 0.05 where p-value is not significant if greater than 5%; and significant if lesser than 5%.

Table 2. The Mean Difference of the Students' Pretest Performance Between the Control Group (Conventional Approach) and Experimental Group (Project –based Learning)

Topic	*G1 (Experimental Group)*		*G2 (Control Group)*		Computed t-value	P-value	Result
	Mean	(z-value) Description	Mean	(z-value) Description			
Redox Reaction	23.04	(-23.32) Below Average	24.52	(-19.04) Below Average	0.84	0.407	*Not Significantly Different*

The p-value indicated that there was no significant difference in the performance of learners in the Redox Reaction (p= 0.407). This result signifies that there was no statistical difference between the pre-test score of the learners of these two groups at the 0.05 level. Since the p-value was greater than the seated standard. These implied that prior to the study it can be said that both groups pre-learning levels in the selected lessons in chemistry were almost the same. According to Ilayon (2014) and Harmer (2001), A task given to the students promotes an achievement of knowledge through types of interaction. This allows the learners to use all they know. consequently, learners are less likely to remember the concept without experiencing it. On the other hand, to be highly effective in learning, the skills and concepts needs to be experienced. It means that the teacher needs to give learning instructions to students for them to gain learning. Thus making it necessary for students to learn more of the concepts.

Table 3. The Mean Difference of the Students' Posttest Performance Between the Control Group (Conventional Approach) and Experimental Group (Project –based Learning)

Topic	*G1 (Experimental Group)*		*G2 (Control Group)*		Computed t-value	P-value	Result
	Mean	(z-value) Description	Mean	(z-value) Description			
Redox Reaction	30.96	(2.125) Above Average	26.76	(-2.075) Below Average	2.70	0.010	*Significantly Different*

It can be perceived from Table 3 that the z-test scores in the areas of chemistry showed that the experimental group had higher level of achievements compared to control group. Additionally, the mean score of the experimental group, was also greater than that of the control group (M= 26.76) which corresponded to a mean percentage score (MPS) of 61.92% and 53.52% respectively, of the perfect score of 50. Moreover, it can be noticed that there was a great mean difference from the students' pre-posttest from topic Redox Reactions. In this topic, the learners were oriented on the different ways of using laboratory materials and chemicals. Other than mixing the chemicals using the molecular formula, they got the value of quantities from actual measurement using devices such as the digital weighing scale, and graduated cylinder. In connection with this, the students were involved in an actual hands-on activity on the concepts. This mean more learning and improving the analytical skills on the part of the learners. It shown that there was a positive learning experience of the students. Based from Blumenfeld (2001), learners pursue solutions to a variety of media that entails active experimentation with hands on approach to acquiring knowledge. In addition, the p-value was (p=0.010) indicated that there was a statistically significant difference between the post-test scores of these two groups (control and experimental groups) of learners at 0.05 level, since the p=value was less than the seated standard. This indicated that after the study's experimental process, it can be stated that both groups' post-learning levels in topic Redox Reaction in favor on the experimental group. To determine the significant difference between the mean gain score of the achievement in pre-posttest in physics, the t-test for related sample was used in comparing the Table2 and 3 results. The results are presented in Table 4 for the control group and Table 5 for the experimental group. The p-value standard was 5%, where the p-value is not significant if greater than 5%; and significant if lesser than 5%.

Table 4. The Mean Gain Between the Students' Pretest and Posttest in Chemistry Performance of the Control Group (Conventional Approach) and Experimental Group (Project-Based Learning)

Topic	*Group*	*Tests*	*Mean Score*	*Main Gain*	*P-value*	*Result*
Redox Reaction	G1 Experimental Group	Pretest	23.04	7.92	0.0000041	*Significantly Improved*
		Posttest	30.96			
	G2 Control Group	Pretest	24.52	2.24	0.047	*Significantly Improved*
		Posttest	26.76			

The findings in Table 4 showed that the mean gain of the experimental group with p-value of 0.00000041 which is almost zero was found to be significantly higher, compared to those of the control group with p-value of 0.047 at the 5% level of significance. The result implied that though both groups increase their level of performance after the lesson, the experimental group had higher level of performance compared to the control group. According to Bell (2010), PBL is an innovative teaching pedagogy that addresses a multitude of skills critical for the success of the 21st century leaners. The main advantage of PBL is that the students developed wider skills, increase students' motivation and enjoyment of the subject matter, learn revision, enhance outreach and engagement beyond academic and advantage for the teacher (Harmer and Stroke, 2014). Since the standard followed in PBL are simulation of those in the real world, this allow an individual to take responsibility, to visualize goals; thus, increasing the performance of improving the task. Learner in the experimental group performed better than those learners exposed using the conventional approach, based on the result showed a favorable interest towards the subject chemistry. Thus, it can be said that this method is effective in improving the interest of learners towards chemistry. According to Redmond (2014) teachers are very helpful in identifying the key on how to intensify PBL in classroom. Learners who are shy and sometimes afraid to ask questions from the teacher are encouraged to participate in the discussion when it is individual explanation is required (Salandanan, 1988) Critiques given by the classmates and peers provides feedback, builds self-directed learning and self-confident.

Challenges and Benefits Experienced by Teacher and Students on PBL: To give answer to this problem, the researcher conducted a Group Discussion with the randomly selected students from the experimental group. They consisted of 10 to 12 students representing the different sub-groups in the experimental class. The following questions were asked in the process: (1) What are your thoughts about PBL as a teaching strategy? (2) Do you find PBL helpful in your learning process? (3) What are the benefits you attain from the project? (4) What do you think are the challenges you encounter while doing the project?

The list represents the challenges and benefits experienced by both students and the teacher on the PBL:

Challenges	Benefits
• Clarity of instruction • Time Management • Knowledge of Technology Used • Facilitative Skills	• Collaborative Learning with the students • Social participation • Strengthen the bond between students • Student Scaffolding

The teacher in teaching PBL needs clarity of instructions. The students needed to be guided accordingly in every steps they took from the start down to its last phase of the project. Content is made accessibility by allowing learners to engage in problems, example, and contexts that connect new idea to personally relevant prior knowledge. Thus effective instruction should provide opportunities for students to ask their own questions; refine those questions through the design and conduct personally relevant investigation (Linn *et al.,* 2004). Time management was one of the challenging part in the study. Both the learners and teachers needed to meet the targeted time of every activity (Kauchack *et al.,* 2008). Some of the activities were expected to be done beyond the expected time, thus learners had to extend their time for the activities. Moreover, the teacher should provide ample time to monitor and tsay with learners during the activity. Textbooks is not enough to widen the information on what learners wanted to explore, thus the demands of using technology was quite necessary. Without its convenience, the learners would not be able to gather enough information about the background of the topic for the project. The optimum management in the computer must be monitored so that all the learners would be able to use (Alexander *et al.,* 1998). The steps in producing

the project must be clearly emphasized by the learners. With this, it requires the facilitative skills of the teacher. According to Krajcik and Shin (2014), A driving question is a well-designed question that students and teacher elaborate, explore, and answer during the making of the project that would carefully lead the learners to the construction an overall view of the project and helps learners understand the goals and objectives of the project. Furthermore, the study has also benefits. Working on Project–based learning promotes collaborative learning. The collaborative working environment in PBL encourages learners to work in divers learning settings with students from different socio-economic background. Variety of skills and abilities a project may require help learners with diverse abilities contribute to the success of the project in various aspect (Kalda *et al.,* 2011). This supports the idea of Borko *et al.* (1999) that learners gain knowledge more by participating and collaborating in activities offered in the schools. According to Vygotsky (1978), Helping students learn from others is grounded in social constructivism. Utilizing PBL improved the social characteristics of the students. They developed good working relationships and boosted their self-confidence (Saltala, 2010). Students in their small group discussion enhance the power of reasoning, understanding of the concept and critical thinking in solving the problem. PBL promotes good camaraderie among them. It gave learners an opportunity to develop team building and avoid conflict within. According to Brown *et al.* (2009), Through regular teacher interaction and feedback to students, they developed the freedom to verbalize their learning and participation was highly valued among them. With this, they felt active and comfortable learning the subject concept. Scaffolding students to make their thinking visible provides opportunities for students to explicitly monitor their own learning, which encourage reflection and more accurately scientific process (Bell, 2010). Providing multiple representations is essential to allow students to actively participate in the interpretative process of PBL. Scaffold encourage the learners to become active-creative members of the learning team (Jackson, 2000).

Findings, Conclusions and Recommendations

This chapter presents the summary of findings based on the statistical analysis and objectives of the data collected. The conclusions were expressed based from the findings and the recommendations design to make best use of the effect revealed in the subject study.

Summary of Findings

Based on the results of the pre-test and post-test of Conventional Approach and PBL groups, a significant difference exists between the academic performance of learners exposed to each group, in favor to Project-based learning group. According to the interview conducted by the researcher, the evident challenges for both learners and teacher were the Clarity of Instruction, Focus of the students to learn, Time Management, Knowledge of Technology Used, Facilitative Skills; and the benefits were: Collaborative Learning with the students, Social participation, Strengthen the bond between students, Critical Thinking Skills.

Conclusion

As discovered in the findings of the study, Project-Based Learning is an effective teaching strategy that can be utilized in teaching chemistry to enhance the performance of the learners when it comes to academic.

Recommendation

Based from the results and findings of the study, the following are hereby recommended:

Project-based learning requires a lot of time management from the teacher. To be able to make a meaningful project smoothly the teacher needs to make sure that the plan is student centered, real-world problem that incorporate collaboration, and must produce an outcome. The study proved the effectiveness of PBL in increasing the academic achievement in Chemistry. Further investigation is needed to see the potential of PBL in other subject area, 21st century learning skills, and learners' perception to determine the lifelong learning feasibility of the approach. Carrying PBL is not easy it needs time, effort intellect and persistence, thus the school should provide and help the teacher support the finances to procure needed chemistry materials and chemicals. An exposure to seminar-workshop that focuses to Project-based Learning is recommended to enhance the awareness and ability of the teacher to teach using PBL strategy to the learners.

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