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PROBLEM-BASED LEARNING AND ITS EFFECTS ON ACHIEVEMENT AND ATTITUDE IN SCIENCE AMONG GRADE 8 STUDENTS

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Abstract

The study used quasi-experimental research design to investigate the effects of problem-based learning (PBL) on the attitude and achievement in science among Grade 8 students in a public high school in the Philippines. A problem-based learning module was developed using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. It was used in teaching science. On the other hand, the Attitude Questionnaire in Science was adopted to describe the attitudes of students in both the control and experimental groups. Data were analysed through descriptive statistics. Prior to teaching science using PBL, the students showed different attitudes and had a low achievement in terms of mean percentage score. But after the implementation of PBL instruction, the students got positive attitude in science. They find the experience interesting and challenging at the same time. The PBL instruction in the experimental group caused a better understanding of topics in science than the lecture-based instruction. Given the results, the study recommended specific teaching techniques that will be useful in applying PBL to develop the students' attitude and achievement in science especially in a blended-learning setup in this new normal.

Keywords: Achievement; Attitude; Problem-based learning; Science.

Resumo

O estudo usou um projeto de pesquisa quase experimental para investigar os efeitos da aprendizagem baseada em problemas (PBL) na atitude e desempenho em ciências entre alunos da 8ª série em uma escola pública nas Filipinas. Um módulo de aprendizagem baseada em problemas foi desenvolvido usando o modelo ADDIE (Análise, Projeto, Desenvolvimento, Implementação, Avaliação). Foi usado no ensino de ciências. Por outro lado, o Questionário de Atitude em Ciências foi adotado para descrever as atitudes dos alunos dos grupos de controle e experimental. Os dados foram analisados por meio de estatística descritiva. Antes de ensinar ciências usando PBL, os alunos apresentavam atitudes diferentes e tinham um desempenho baixo em termos de pontuação média percentual. Mas após a implementação da instrução PBL, os alunos obtiveram uma atitude positiva em ciências. Eles acham a experiência interessante e desafiadora ao mesmo tempo. A instrução PBL no grupo experimental causou uma melhor compreensão dos tópicos em ciências do que a instrução baseada em palestras. Diante dos resultados, o estudo recomendou técnicas de ensino específicas que serão úteis na aplicação do PBL para desenvolver a atitude e o desempenho dos alunos em ciências, especialmente em uma configuração de aprendizado combinado neste novo normal.

Palavras-chave: Conquista; Atitude; Aprendizagem baseada em problemas; Ciência.

INTRODUCTION

Problem-based learning (PBL) is commonly compared to a conventional learning control group (Khoshnevisasl *et al.*, 2014). Lecture-based learning is primarily called a presentation of materials by a lecturer. Learning is teacher centred, with the trainer delivering materials in a very lecture-based format to passive learners. Textbooks are often the first source for content and written examinations are used because the typical mode of assessment. Lecture based learning has also been called didactic, conventional, and teacher-guided teaching (Leary, 2012).

PBL begins with the presentation of an ill-structured problem to be solved that has potentially multiple solutions. Teachers act as facilitators throughout the strategy, guiding learners with meta-cognitive questions, and learners actively construct knowledge by defining learning goals, seeking information to build upon prior knowledge, reflecting on the training process, and participating in active group collaboration (Barrows, 1998). Most of the PBL research and practice is in medical education, but it recently has branched out into all disciplines (Savery, & Duffy, 1995).

PBL is recognized as an inquiry approach because it prompts student's curiosity to solve problems, but also since questioning and research are at the core of the development of the process of learning. Furthermore, an inquiry approach also relates to activities in which students develop knowledge and the understanding of scientific ideas, as well as catch on how scientists study the natural world (Bulunuz, 2007).

PBL targets to develop the skills of students in the areas of communication, critical thinking, scientific reasoning and knowledge, decision making, assessment and evaluation. The competences are essential towards a lifelong learning process (Williams, 2009).

The Constitution of the Philippines encourages all educational institutions to promote critical and creative thinking among the Filipinos. The Bureau of Secondary Education endorses the following objectives in science to make it possible by: (1) promoting student awareness of the relevance of science to life, and (2) developing critical and creative thinking skills as well as skills in problem solving (Bureau of Secondary Education, 2009). Many education systems are characterized by learning through memorization, imitation learning, and modelling learning (Hamidi *et al.*, 2011; Helikar *et al*., 2015). These systems are important for the acquisition of basic knowledge and skills. However, these are not enough for students to develop the necessary thinking skills to deal with real-world problems.

One example is the Trends in International Mathematics and Science Study (TIMSS). In 2003, for high school, the country ranked only 43rd out of 46 participating countries in HS II Science. For elementary, the fourth-grade participants ranked 23rd out of 25 countries in science. In 2008, Philippines stopped participating in the survey, perhaps after receiving such dreary scores (Ambag, 2018).

More recently, the country participated within the 2018 Program for International Student Assessment (PISA). The study conducted by the Organization for Economic Cooperation and Development (OECD) ranked 79 participating economies supported their student performance in reading, science, and mathematics. Filipino students had very cheap average reading comprehension score (340 points, below the 487-point survey average). They also ranked second to last in science (357) and math (353) below the 489-point average for both subjects (Ambag, 2018).

The concern with the length of programs and preparing the students for national exams often overlaps any attempts to improve learning by changing the teaching process. Competence's development is often overlapped by the acquisition of knowledge, to ensure school achievements in standardized exams.

Research shows PBL that is more effective in promoting students learning in science, social studies, mathematics, and literacy (Kingston, 2018). The effect of teachers' adaptations of a middle school science inquiry-oriented curriculum unit on student learning using PBL intervention, Investigating and Questioning Our World Through Science and Technology (IQWST) curriculum units shows considerable learning with significant variation across teachers and students showed gains from pre- to post-test scores (Fogleman *et al.*, 2011).

PBL aims to develop communication skills, critical thinking, scientific reasoning and knowledge, decision-making, assessment, and self-evaluation (Williams, 2009). However, whenever a new teaching methodology is implemented within science classrooms, many doubts and criticisms arise from school directors, some teachers, students and even parents. Several studies have already provided some experimental evidence that backs the assumption that the PBL methodology does not affect the students' factual knowledge acquisition when compared with more traditional lecture-based learning (Zahid *et al.*, 2016). Other studies suggest that PBL is significant to the development of generic and scientific skills since students are faced with complex problems and must look for solutions creatively (Zahid *et al.*, 2016). Like in medical education, where PBL has been largely applied and investigated, design-based research is still needed to enrich our understanding of the nature of PBL (Dolmans *et al.*, 2000).

With the low-test scores and low interest in science of students, it is important that teachers develop and deliver improvement activities. In the absence of PBL teaching module in science, the researcher designed and implemented one for Grade 8 students. The study aimed to analyse the effects of PBL on the attitude and achievement towards science among Grade 8 students.

The study sought answers to the following questions:

1. What is the attitude of the students towards learning science before and after the implementation of PBL?

2. What is the achievement of students in science before and after the implementation of PBL?

Specifically, the study: (i) assessed the attitude of the students towards learning science before and after the implementation of PBL; and (ii) analysed the achievement of students in science before and after the implementation of PBL.

MATERIALS AND METHODS

Research design

This study used quasi-experimental design. This design aims as a 'intervention' in which the treatment – consisting of the elements of the program being evaluated – is tested to see how well it achieves its objectives, as measured by a pre-defined set of indicators. Assignment to conditions (treatment versus no treatment or comparison) is by means of self-selection. It identifies a comparison group that is as similar as possible to the treatment group in terms of basic (pre-intervention) characteristics. The comparison group shows what the outcomes would have been if the program had not been implemented (i.e., the counterfactual). The program can therefore be said to have caused any difference in outcomes between treatment groups and comparison groups (White, & Sabarwal, 2014).

In this study, the experimental group received the treatment implementation of problem-based learning and control group received lecture-based instructions. This study used a quantitative approach, including a survey questionnaire, pre-test, and post-test to analyse the effects of PBL on achievement and attitude towards science.

Research participants

The respondents of the study were the Grade 8 students at a public secondary school in Santa Rosa, Laguna, Philippines. Purposively selected students were distributed into two classes randomly. The 40 students were equally divided depending on their scores in the pre-test. The scores were arranged from highest to lowest. Then the students were grouped alternately by their scores to form two equally heterogeneous groups. That is, 20 students received PBL instruction, and 20 students received lecture-based instruction.

The Grade 8 students were composed of 50 per cent male and 50 per cent female. The age of the students varies since not all of them started studying at the same age. Fifty-five per cent of them are 13 years old. In terms of their 3rd quarter grades they are heterogenous since 10 per cent got 99-95, 11 per cent got 94-90, 16 per cent got 89.85, 43 per cent got 84-80, 10 per cent got 79-75, and no one got 74 and below.

Instrumentation

Pre-test and post-test in science

The researcher developed the test. It consists of 20 multiple-choice questions. Each question had one correct answer and 3 distracters. Content of the test is determined from the lecture materials and some science books. The items are related to the diseases of digestive system resulting from nutrient deficiency and ingestion of harmful substances. During the developmental stage of the test the following procedures were followed: first the instructional objectives were stated. Second, the books were carefully examined to find items, which matched to the instructional objectives. Table of specification was also made to identify the easy, average, and difficult questions of the test. Then the tests were subjected to validation by the experts in the field and all the comments were considered. These teachers were asked to review the questions and revised those that are not clear and have some grammatical errors. Then pilot testing to 20 students was also conducted. After that, item analysis was made and removed the easy questions and revised the difficult ones. Finally, the revisions on the questionnaire were made before it was applied to both control and experimental groups.

Student's attitude towards science

To measure the attitude of learners towards science. Attitude Questionnaire Science (AQS) by the Faculty of Education, University of Cambridge (2010) was utilized.

Attitude Questionnaire Science consists of 25 items to measure the attitude of students towards science. It is about openness to learning opportunities, self-concept, initiative, and independence in learning, informed acceptance of responsibility for ones' own learning, love of learning, creativity, positive orientation to the long run, and to use basic study skills in science.

Each item has a seven-point Likert scale including '1 = strongly disagree', '2 = disagree', '3 = tend to disagree', '4 = neither agree nor disagree', '5 = tend to agree', '6 = agree', '7 = strongly agree'. Each point has a score equal to its number. For example, in positively stated items, selecting agree, scores 6 points for that item. The summation of all 25 item scores equals the total score of the Attitude Questionnaire Science. The scale contains 22 positive statement item and three negative statement items. Items number 3, 9, and 15 are negative statements items that are scored reversely, and other item is positive statements items. Negative statements items are used as a means of avoiding participant to answer similarly and to easily avoid response set.

The tool was pilot tested to 20 students. Using Cronbach alpha to test its reliability, the value 0.85 implies that the tool is good to use for the research.

Open-ended Question

One open-ended question was asked about the students' experience in PBL class.

Designing the Problem-based Learning Module in Science

ADDIE model was adopted in creating the instructional material in this study. It stands for analyse, design, develop, implement, and evaluate. This order, however, does not impose a strict linear progression through the steps (Kurt, 2018).

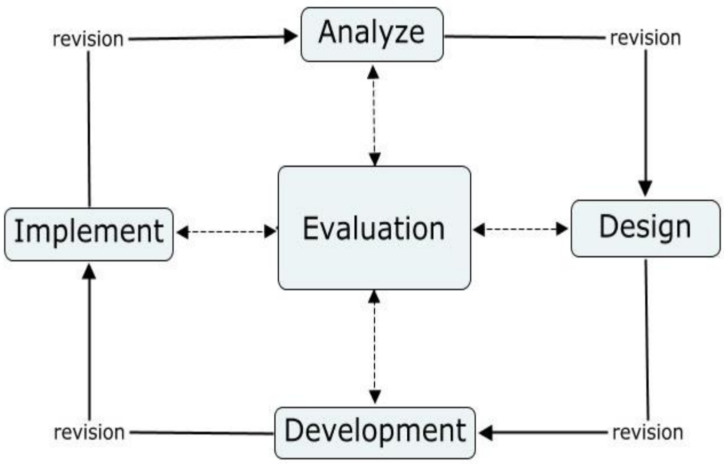

Figure 1: ADDIE Model (Kurt, 2018)

Analysis Phase

In this phase, an attitude survey was conducted. Prior to the design, learners already have the knowledge on related concepts to the diseases of the digestive system. It must also be noted that some learners are not used in researching using the internet.

Design Phase

The design phase involved the identification of theories that were embraced in the formulating of the teaching guide. PBL is the focus in making the material. Six steps were identified by Lauridsen (2012) in conducting problem-based learning.

The lesson followed the most essential learning competencies (MELC's) by the Philippine Department of Education (DepEd). The lesson plan includes the standards and objectives to be met, and activities prescribed by the DepEd. This follows the 5 E's constructive instruction model which stand for engage, explore, explain, elaborate/extend, and evaluate (Bybee, 2014).

Development Phase

The development of the teaching module involved the use of real data, actual findings, and reports. The material used was sent via google classroom since the school has shifted to online class and applied either synchronous or asynchronous. Power point presentation and hand-outs were used during the online class.

The learning guide was developed by the researcher, and it was checked by the principal and Science coordinator from a public high school.

Implementation Phase

A pre-implementation of the teaching material developed was done involving another section of Grade 8 students before it was implemented to selected 20 Grade 8 students.

Teacher began by clarifying unclear terms and concepts about the diseases of the digestive system for the students at the start of the lesson. This helped to remove an early learning barrier so that students can focus more on finding solutions to the problem that they presented regarding the topic. Second, problem was defined by the students. Students asked several different questions that address the issue they used to guide their answer to the problem.

Evaluation Phase

Feedback was collected through interviews and effectiveness was evaluated through a post test.

Table 1. Problem-based learning versus lectured-based learning.

Activity	Problem-based Learning	Lectured-based Learning
Motivation	A case study entitled "*What's Wrong with Kuya Juan*?" was given to the class.	A video clip regarding the new topic was presented to the class.
Objectives	The objectives which are derived from the curriculum guide are presented to the class.	The objectives which are derived from the curriculum guide are presented to the class.
Review	Used of inquiry questions about the parts and functions of the digestive system.	Review of concepts, part and functions of the digestive system are done through recitation.
Present the content	The students filled out the handouts with the clues they got from the case study.	Definitions, concepts, and steps are directly given to the students. This is also when demonstration by teacher is done.
Guided Practice	Curated list of resources used in the research was given in the class.	The example of diseases resulting from nutrient deficiency and ingestion of harmful substances are discussed.
Elicit performance (practice)	Conducted a presentation of a diseases resulting from nutrient deficiency and ingestion of harmful substances and their prevention and treatment.	Other example of the diseases is asked by the teacher from the students and its causes.

Activity	Problem-based Learning	Lectured-based Learning
Provide feedback	The students consulted with the teacher about their research on chosen diseases.	The students had an activity on how to take good care of the digestive system.
Assess performance	The class wrapped up any loose ends on the projects. Each team had presented their findings.	The students had a recitation.
Enhance retention and transfer to the job	Post-test was given to the class	Post-test was given to the class

Data Analysis

The mean percentage scores (MPS) and Science Attitude Questionnaires scores were analysed using descriptive measures such as mean and standard deviations.

The pre-test and post-test were also analysed using descriptive measures such mean scores and standard deviations.

An open-ended question about the experiences of the students with the PBL was asked to enrich the discussion of findings. Responses to the interview were transcribed verbatim and were carefully analysed. Themes were made from these to give a summary on the general attitude of students towards the topics taught to them.

RESULTS AND DISCUSSIONS

Students' attitude towards science before and after the implementation of PBL

Top five most attitude in science that students agreed

Table 2 presents the pre-survey results of students' attitude towards learning science. The table shows that the respondents top five most attitude in science that they agree are: *"School science is relevant to life in today's world."* with a mean of 5.63. The respondents tend to agree with "*Many of the things we learn in science are useful elsewhere."* with a mean of 5.45, *"The science we learn at school is useful in other subjects."* with a mean of 5.30, *"Everybody will need to know some science in their adult life."* with a mean of 5.28, *"I find science difficult."* with a mean of 5.10.

Bottom five attitude in science that students agreed

The bottom 5 of the results shows are: *"I think I could cope with a harder science course."* with a mean of 2.38,*"I can imagine choosing a career connected to science."* with a mean of 2.23, *"I think I could cope with a harder science course."* with a mean of 2.38*, "I enjoy studying science"* with a mean of 3.10, "*I can learn science well without really understanding it*" with a mean of 3.50, and *"Learning science is important for getting a job in the future"* with a mean of 3.70.

Table 2. Pre-survey results of students' attitude towards learning science.

Attitude towards learning science	Mean	Verbal Interpretation	Rank
The science we learn at school is useful in other subjects.	5.30	Tend to Agree	3
Understanding the science, we're doing is important to me.	4.88	Tend to Agree	6
Science is boring.	4.05	Neither Agree nor Disagree	18
I can usually manage the science we do at school.	4.53	Tend to Agree	11
I'd like a job that involves using science.	4.23	Neither Agree nor Disagree	15
Many of the things we learn in science are useful elsewhere.	5.45	Tend to Agree	2
I like learning science.	4.73	Tend to Agree	8

Attitude towards learning science	Mean	Verbal Interpretation	Rank
I think things through in science until they're clear to me.	4.83	Tend to Agree	7
I find science difficult.	5.10	Tend to Agree	5
I might go on to do something related to science after I leave school.	4.10	Neither Agree nor Disagree	17
School science is relevant to life in today's world.	5.63	Agree	1
I look forward to doing science.	4.43	Neither Agree nor Disagree	13.5
I like to know the thinking behind the science I'm studying.	4.63	Tend to Agree	10
I'm good at science.	3.73	Neither Agree nor Disagree	20
I'll avoid science once I leave school.	4.65	Tend to Agree	9
I can learn science well without really understanding it.	3.50	Neither Agree nor Disagree	22
Everybody will need to know some science in their adult life.	5.28	Tend to Agree	4
I find science interesting.	4.43	Neither Agree nor Disagree	13.5
Even when it gets hard, I can do our science work.	4.20	Neither Agree nor Disagree	16
I plan to carry on studying science when the time comes to choose.	4.03	Neither Agree nor Disagree	19
I want to make sense of what I'm learning in science.	4.50	Tend to Agree	12
Learning science is important for getting a job in the future.	3.70	Neither Agree nor Disagree	21
I enjoy studying science.	3.10	Tend to Disagree	23
I think I could cope with a harder science course.	2.38	Disagree	24
I can imagine choosing a career connected to science.	2.23	Disagree	25
General Weighted Mean	**4.30**	**Neither Agree nor Disagree**	

Attitude of students towards science before the implementation of PBL

The students' different attitude towards science depends on the weight of the advantage of the lesson with their daily lives, teacher factor and the strategy in teaching the lesson. From the interviews conducted a student mentioned, *"Mas madali po ako makaintindi sa science kapag alam ko na yung topic magagamit or magagawa po sa totoong buhay* (I can easily understand science if we know that the topic is useful and can be done in real life). *"Mahirap po sa akin ang science kaya ayoko po ng trabaho na may science"* (Science is hard for me, that is why I do not want to have a job related to science.) Twenty-nine out of 40 student-respondents find science a difficult subject. Most of them really want to understand science but their lack of motivation due to this view of science as difficult subject is one of the hindrances for them to pursue it. *"Minsan po kasi depende po sa topic at sa mood ko kung gusto ko po yung science. Minsan po depende din po sa teacher kaya paiba-iba din po talaga ng ugali ko."* (Sometimes it depends upon the topic and my mood if I like science. Sometimes it is also depending on who the teacher is that is why I have different attitudes.

Attitudes towards science are the positive or negative opinions that individuals have about science, based on their perception of science—as a school subject, as an aspect of society, and as a human effort. Attitude is a relatively more willing construct that slowly changes and influences a wide range of science perceptions, views, and values, as well as their interest in pursuing potential careers in science (Osborne *et al.*, 2010). According to Raved and Assaraf (2011), students had more positive attitude once they felt a reference to the teacher and the relevance of the topic. Studies during this area suggest that students prefer learning experiences involving activity-based practical work, discussion, research and stressing the relevance of science through problem-based learning (Juuti *et al.*, 2010).

This is supported by the study of Kan'an and Osman (2016) who analysed PBL's effects on student attitude in terms of education level. The analysis revealed that effect sizes of PBL on student attitude do not vary according to education level. In other words, there is no difference among the effect sizes obtained from problem-based learning's implementations conducted in primary school, middle school, high school, and better education levels. Üstün's (2012) study which has been specified that problem-based learning implementation in primary, secondary or instruction levels does not affect students' attitude toward courses. On the opposite hand, Akçay (2017) compared levels of attitudes of the first, second, third, and fourth grade students of a preschool toward problem-based learning. As a result of the analysis, it has been found that PBL contains a low positive effect on students' attitude. It implies that PBL is effective in helping students gain a positive attitude toward courses.

Table 3 presents the significant differences between the pre-survey and post-survey on students' attitude towards science after the implementation of PBL. The mean of the pre-survey is 4.59 and the mean of the post-survey is 5.61. This means that even if the pre-survey and post-survey have a different means they both have the same verbal interpretation which tends to agree.

Table 3. Pre-survey and post-survey results of attitude towards science.

Attitude toward Science	Mean	Verbal Interpretation
Before Implementation of Problem-based Learning	4.59	Tend to Agree
After Implementation of Problem-based Learning	5.10	Tend to Agree

Attitude of students towards science after the implementation of PBL

Using the PBL the students enjoyed the lesson even if it contains a self-learning portion wherein, they need to have research. It boosts their willingness to read and study about a certain topic so that they will be able to contribute to their groupwork. They felt that they really belong to a certain group since all of them have a part to do.

From the interviews conducted after the implementation of PBL, 31 students find science an interesting and enjoyable subject. Though they had the impression that science is a difficult subject, and yet their teacher's use of PBL provides a way to make science a mind-broadening and enjoyable subject. As a student mentioned, *"Okay naman po yung class natin nung gumamit po kayo ng bagong technique na medyo nakapag-engganyo akin na magustuhan yung subject kasi po nagkadahilan po ako magstudy po Ma'am."* (It is okay that you use new technique that somehow encouraged me to like the subject because I had the reason to study Ma'am.), *"Kaya po siguro hindi ko pa masyado makita yung sarili ko to have a job related to science o gustuhin aralin yung science dahil minsan naiisip ko pa din po na mahirap siya."* (Maybe one of the reasons for me not to see myself having a job related to science or for me to like science yet because sometimes I think that it is hard. *"Tend to agree po siguro yung mas madami naming sagot kasi siguro po nabago na yung paggusto namin sa science, medyo gusto na po namin siya pero hindi pa po masyado baka may mga need pa po kasi kaming iimprove sa subject."* (We mostly answered tend to agree maybe because we somehow developed our interest in science but not that much. We wanted it but we think we still need to have improvement in the subject."

According to Raved and Assaraf (2011), students had more positive attitude once they felt a reference to the teacher and the relevance of the topic. Studies during this area suggest that students prefer learning experiences involving activity-based practical work, discussion, research and stressing the relevance of science through PBL (Juuti *et al.*, 2010).

The responses of the students revealed that PBL is a student-centred method which helps them to construct knowledge through working and discussing actively in groups. They stated that teachers hold responsibly to supply guidance instead of giving complete information and solutions. Their response emphasizes that students were active learner (asking, searching, discussing, and looking for information through different resources). Finally, the PBL scenarios stimulated and guided students' learning.

According to the results, generally students had positive attitude towards PBL, and consequently, and their interests toward science (Alper *et al.*, 2014). However, within the literature, additionally, as some studies which argue that PBL contains a positive effect (Kusdemir *et al.*, 2013); some argue that PBL encompasses a negative effect or no effect positively or negatively on students' attitude as compared to conventional teaching (Tugwell, 2020; Marklin Reynolds & Hancock, 2010). So, it seems that individual studies investigating PBL's effects on student attitude toward courses when compared to conventional teaching.

The findings showed that the student who obtained PBL guidance methods showed higher scientific reasoning skills compared to the traditional approach. The addition of cognitive scaffolding has had important effects. Interviews found that PBL had the ability to create a science culture in the classroom, and that open and versatile problem-based learning facilitation strategies used by science teachers were more successful in creating a better learning atmosphere (Osman *et al.*, 2013).

Comparison between pre-test and post-test scores of achievements in science

The students from PBL group obtained a mean of 5.65 in the pre-test and 9.85 in the post-test (Table 4). The achievement of students in PBL group increased to 74.34 per cent. While the students from Lecture-Based group obtained a mean of 6.25 in the pre-test and 7 in the post-test. The achievement of students in Lecture-Based only increased to 12 per cent. It only shows that in the pre-test the Lecture-Based have a higher mean that the PBL. While in the post test the PBL have a higher mean than the Lecture-Based. It means that PBL is effective to use in teaching.

Table 4. Pre-test and post-test results of students' achievement in science **.**

Groups	Pre-test Mean	SD	Post-test Mean	SD
PBL	5.65	3.12	9.85	3.38
Lecture-Based	6.25	3.33	7	2.86

In the study Benli and Sarikaya (2012), they compared the effects of the problem-based learning instruction methods with the control group instructed by the traditional approach. There was a major difference between the experimental and control group students" in favour of the experimental group. PBL had a positive impact on students" science achievement and therefore the permanence of information.

The relationship between achievement score, and students' achievement level reached an agreement with the findings of the study of Abdisa and Getinet (2012). They found that students' achievement encompasses a strong relationship with their background performance levels for example their problem solving and critical thinking skills. Also, prior knowledge was the most effective predictor of achievement which is the main feature of PBL.

The results show a significant difference within the achievement between the students' performance within the post-test after they were exposed to PBL and traditional instructional approach of teaching. With this, PBL can improve analytical skills through evaluation and inferences of data (Zhou *et al.*, 2013). In an exceedingly typical PBL classroom, students solve problems as they are going through the inquiry process during a very real-life context. When students engaged in PBL, teachers encourage them to explore possibilities, invent alternative solutions, collaborate with other students, undertake ideas and hypotheses, revising their thinking, and presenting their best solutions. Hands-on activities provide students with opportunities to interact in exploration and make meaningful conclusions (Zhou *et al.*, 2013). The study of Putra *et al.* (2021) that was an experimental pre-and post-test design and a comparison of the PBL group with the control group results have shown that the implementation of the PBL model has resulted in substantial changes in academic achievement.

Students' experience in PBL class

Using PBL helps the student to self-study and to communicate with their classmates. It became a way for them to collaborate even if they are not physically at school. Usually, they just memorize the lesson without fully understanding it but using PBL they learned to have deep research regarding a certain topic. From the interviews conducted after the implementation of PBL a student mentioned, *"Yung problem-based learning po nakatulong sa amin para gumana yung utak namin para magtanong at ma-curious. Nakatulong po siya sa amin na magresearch at magbasa. Lahat po kaming member ng group may ambag po para makasagot kami. Masaya po siya kasi kahit hindi kami magkakasama dahil may COVID nagcocommunicate po kami sa isa't-isa. Bago po namin malaman yung answer sa problem madami na po kami natutunan* (problem-based learning helps us to think and start to have questions and become curious. It helps us to do research and read. All of us in the group have contribution for us to answer. We are happy even if we are not physically together due to COVID, we are still communicating with each other. Even before having an answer for the problem, we have already learned a lot along the way. *"Yung mga scenarios nakakatuwa basahin kasi nakaka-curious po kung ano ang sakit nung tao dun. Tapos kahit walang tulong ng teacher masasagot po namin yung problem. Sa ngayon po mostly ang subjects namin ay self-learning at kung ganito po palagi yung gagawin sa klase* *magiging interesado po kami sa lesson at pagbabasa lalo na po at groupings.”* (The scenarios are fun to read because they made us curious of the kind of sickness that the person has in the story. Even without the help of the teacher, we can still answer the problem. Like right now, most of our subjects are self-learning and if problem-based learning will remain to be used in our class, we will be more interested in our lessons and reading specially when it is done in group. *“Simula elementary kapag nag-aaral ng body systems laging pinapamemorize lang sa amin pero ngayon ibang way naman binigyan po kami ng problem para malaman yung sakit nung tao kaya mas naging interesado kami. Tapos syempre po mas need po naming magbasa lalo kasi para po di mali yung sagot namin. Kaya po nung exam madali na po samin kasi ang dami na po naming sakit na nabasa.”* Since elementary we used to study the body system and we only memorize everything about it. But now it is done in a different way. Our teacher gave us a problem for us to know the disease that a person has which made us more interested. Then we need to read more for us to not get the wrong answer. That is why when answering the test, it becomes easy for us since we have already read a lot about diseases.

Students' responses revealed that PBL improves the following: mentation, social interaction, self-worth, respect others' opinions, problem-solving skills, and using different resources to look about needed information. Also, it improves students' deep understanding through enjoyable environment, and students' responsibility of their own learning. PBL is student-centred and it encourages students to become active learners.

According to the study of Masek and Yamin (2011), in the PBL environment, student learning activities are established. This is because students are engaged to select and define their needs; thus, leads to more successful and valuable group discussions and knowledge acquisition to resolve a real-world scenario. It promotes and enhances students' trust in their problem-solving skills, making them self-directed learners. Both of those features of PBL eventually support students in their future studies in addition to their workplaces. It is necessary to recollect that such trust is fostered by the acceptable guidance that must be given by the teachers.

Another basis is the study of Belland (2010) who found that it is necessary to integrate scaffolding to assist students to complete a problem-based unit. Belland helped to characterize PBL as "a student in small groups (being) with an ill-structured problem or a problem with multiple solutions and solutions".

Despite its apparent simplicity, not only does the adoption of the PBL process involve administrative and academic changes, but it also demands significant individual changes, such as different roles of students. While students are required to have more responsibility for their learning, teachers should relinquish the role of imparter of established scientific knowledge and evaluator of the knowledge reproduced by students (Ribeiro, 2011).

CONCLUSIONS

This study analysed the effects of PBL on the attitude and achievement in science among Grade 8 students. Prior to the implementation of instructions, students got a negative attitude towards science. They find the topic difficult and not interesting. They also exert effort in learning the topics. Students have lower achievement in science before the implementation of both instructions. But after the implementation of PBL instruction, the students got positive attitude in science. They find the experience interesting and challenging at the same time. The PBL instruction in the experimental group caused a better understanding of topics in science than the lecture-based instruction.

The students taught by PBL strategy are more motivated to learning science than their counterparts taught by the lecture-based instruction. This means that students find the example problems very relatable. They liked them being challenging. With these, problem-based learning instruction must be promoted in teaching science rather than teaching students using plain lecture methods, more collaborative and constructivist activities must be provided. It is very helpful with the attitude and achievement since one of the goals of K-12 education is for lifelong learning of the students.

Using of problem-based learning in the new normal setting of conducting classes was also effective. The researcher finds out upon making the problem-based learning module that it can be used in blended learning since it can be designed for synchronous and asynchronous classes.

The students taught by problem-based learning strategy are more inclined to taking responsibility of their own learning than those taught by the conventional strategy.

Results show the potential of the implementation of problem-based learning in teaching and learning science, thus the use of most essential competencies by the Department of Education is recommended. In designing modules, the following teaching techniques are suggested to be intensified:

Use of real-life examples. Examples utilized in class must be within the context or background of the students so they will be able to relate to them. These may be problems they face every day or something they can use for lifelong learning. In the problem-based learning environment, student-directed learning activities are established. This is because, in self-directed learning, students are engaged to select and define their learning needs; thus, leads to more successful and valuable group discussions and knowledge acquisition to resolve a given real-world scenario (Masek & Yamin, 2011)

Use practical work as a part of a learning sequence. Practical science is one among the simplest ways to have interaction pupils and help improve their understanding of theory. When closing practical work, teachers should explain why they need chosen to try to it and what they hope to attain. the sensible activity should fit into a wider sequence of activities, instead of being a stand-alone event. Magsino (2014) has been evaluated as making the teacher bring out the best of the party by carrying out the tasks.

Develop scientific vocabulary. Students must be able to comprehend, analyse, and interpret texts and use scientific language to elucidate ideas and construct evidence-based explanations. Science teachers can help students to be told complex vocabulary by carefully choosing which words to introduce and when.

Allow Time for Collaboration. Students then work on the issues in groups of three to eight students, betting on the number of scholars within the course and therefore the number of accessible instructors or tutors. Both inside and out of doors of faculty time, students work with their groups to resolve problems. Throughout each session the trainer must make sure that all students are involved within the problem-solving process and must familiarize students with the resources needed (e.g. library references, databases) to unravel the issues, moreover as identify common difficulties or misconceptions (Briggs, 2015).

Develop III-Structured Problems. Supported student input about course topics, the teacher develops ill-structured problems, or open-ended problems that have multiple solutions and need students to observe many methods before picking a selected solution. III-structured problems require more information for understanding the matter than is initially available; contain multiple solution paths; change as new information is obtained; prevent students from knowing that they need to make the “right” decision; generate interest and controversy and cause the learner to ask questions; are open-ended and sophisticated enough to need collaboration and thinking beyond recall; and contain content that's authentic to the discipline (Briggs, 2015).

Developing and maintaining the positive attitudes and achievement of students towards science could be a challenge but problem-based learning can help. Instructions are often given in problem-solving for the students to develop their ability of critical thinking and self-learning. Student interest, preference, and background must be considered in developing instructional materials. Additionally, assessment must even be within the context of real-life situations. during this case, instructional materials could also be updated that are within the context and understanding of the students.

Due to some limitations of the study, it is recommended that the study be conducted at the beginning of the semester. During this case, the students will only get to grasp the teacher for the first time and cannot have an influence on their attitudes. It is also recommended that attitudes be analysed through consistent observations similarly. Attitude Questionnaire Science measures only their attitudes as believed by them. With observations, actual behaviour is noted. Other factors that influence learning science may additionally be considered.

More studies on problem-based learning in secondary school may be carried out on other subjects such as mathematics, social studies, etc. A similar study can be made since science is a broad subject that cannot be fully develop in a short period of time. Future study may be done in a longer duration to obtain significant result. Apply the 3C3R model to deeply integrate the problem-based learning in teaching. Studies show that the said model is effective to determine gaps and competencies required for educators to be successful in the problem-based learning intervention, as well as identify the learners’ gaps to be successful in the problem-based learning process.

Use of random selection of respondents was also suggested to be able to use inferential analysis for broader implication of the study. Due to the new normal, educators are challenged to design instructional materials and lessons capable to integrate problem-based learning in the learning process of students. Deeper studies on the relationship of age, sex and performance scores with the problem-based learning are suggested.

Finally, the teaching guide should still be improved by using real-world scenarios that supported students' characteristics, interests, and keenness. With continuous investigation on this area of research, the effectiveness of PBL will be able to be established as one of the recommended teaching approaches in enhancing the students' attitudes and achievements in science.

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