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## IDEAL Method as a Problem-Based Learning Approach in Social Studies

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### ABSTRACT

The purpose of this research is to investigate the effectiveness, applicability, and instructional impact of using the IDEAL (Identify, Demonstrate, Explore, Act, and Look Back) method as a Problem-Based Learning Approach in Social Studies. The IDEAL method as a Problem-Based Learning is a constructivist, student-centered instructional strategy in which students work collaboratively to solve problems and reflect on their learning experiences to advance or gain new knowledge. The one-group pre-test and post-test experimental design were used to complete the study that was carried out for one week. In all, sixty (60) Grade Ten (10) students at Bagong Nayon II National High School were randomly selected as the participants of the study. The respondents in one-group experimental research were taught prescribed by the curriculum of Social Studies using the IDEAL method as a Problem-Based Learning approach. The study shows the IDEAL method as a Problem-Based Learning approach to be a better instructional method for teaching Social Studies. The participants in the one-group experimental research who were taught through the IDEAL method as a PBL performed better as established through the pre-test and post-test scores; and they were also found more motivated towards the Social Studies classes. The data analyses and interpretation suggest that the IDEAL method as a PBL can improve Social Studies teaching and learning practices that lead to the improvement of the students' academic achievement. Hence, it is recommended that teachers use the IDEAL method as a PBL approach in Social Studies classes to enhance the critical and problem solving, communication, collaboration, creativity, and innovation skills of the students.

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Keywords: critical and problem-solving, IDEAL method, problem-based learning approach, Social Studies, students' achievement

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### 1. INTRODUCTION

As an immediate and direct response to the calibration of the educational system in the country, the Department of Education implemented the Republic Act No. 10533 known as the "Enhanced Basic Education Act of 2013" that changes the image of the educational system in the Philippines by establishing, maintaining and supporting a complete, adequate, and unified composition of education appurtenant to the needs of the people, the country and society-at-large (Sec. 2). Therefore, the overall goal of Philippine basic education is functional literacy for all wherein "functional literacy" is defined as embracing 21st-century learning skills and literacy (DepEd, 2015). Through this, it will guarantee the empowerment of the individual to be more competitive and productive in local and global communities, developing creative and critical thinking towards excellence.

However, today's world is a very challenging one and the events that students have to learn about and understand in the world are so complicated. Therefore, teaching and learning methodologies have always been a challenge for many education researchers and their teaching experiences have urged them to look for new ways of designing effective learning environments. In addition, the demand of the 21st-century is so high with their complex environmental, social, and economic pressure that requires the learners as well as the teachers to be more inventive, innovative, hardworking, and flexible, with the motivation, confidence, and skills to use critical and creative thinking positively and independently.

At the outset of the 21st century and where globalization brought many challenges, the demand for acquiring global competency (both for teachers and students) is increasing and the world faces a unique set of interconnected ecological, economic, and social challenges. Social Studies educators are charged with the task of helping their students make sense of these complex social challenges, and at the same time enabling them to respond as critical,

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active, and informed citizens (Sadruddin & Wahab, 2013; Wood, Milligan, & Morgan, 2013). Ironically, it appears that, while these issues have arguably become more complex and pressing in recent years, Social Studies face an increasingly marginal position (Joerges & Nowotny, 2012) in the curriculum. Priority in many schools is now given to numeracy and literacy (UNICEF, 2000; DepEd, 2015) and, at Junior and Senior High School level, a funding preference for the ENSCIMA subjects (English, Science & Technology, and Mathematics) and STEM subjects (Science, Technology, Engineering, and Mathematics) are emerging both in the Philippines and internationally.

Yet, in the face of this, Social Studies still have a unique role to play in society. It is through Social Studies that young people will gain knowledge about the significance of the past, and how society operates today and through a variety of Social Studies disciplines they will gain skills that enable them to scrutinize the complex interplay of social, geographic, political, and economic forces upon people's decisions, actions, and perspectives. It is only by studying people in society and all their complexities, contradictions, and conflicts that young people can become better equipped to participate in the world as citizens. Preparing students to understand the global interconnections will certainly provide an opportunity for them to participate fully in society at local, national, and global levels (Wood, Milligan, & Morgan, 2013).

To develop a positive attitude to confront the future challenges with confidence, and to survive in this increasingly competitive world besides inculcating global awareness, there is a desperate need to engage students and the teachers in the delivery of Social Studies instruction effectively using the IDEAL method as a problem-based learning approach. Teachers are considered the heart and soul of every education system. They are the chief professional who transmits knowledge and enhance bona fide learning in international education. Therefore, the assurance of effective and competent learning will entirely depend on the approaches, methods, and strategies that the teachers will employ to establish an equitable, responsive, and sustainable learning environment.

On that ground, there is the need to develop newer, effective, and innovative instructional strategies that will promote effective teaching-learning outcomes of students in Social Studies. An IDEAL method as a Problem-Based Learning approach is one of such innovative instructional techniques that could be used by teachers to promote effective teaching-learning outcomes of students in Social Studies. It is also an innovative strategy of problem-solving where students sit in a group and contribute ideas spontaneously and offer solutions to those problems. An IDEAL method as a Problem-Based Learning approach elicits higher levels of reflective thinking and creative problem solving, including synthesis, application, and evaluation.

Indeed, this study provided the best method that demonstrates success in creating effective and productive instruction in Social Studies using the IDEAL method as a problem-based learning approach focusing on the development of 21st-century global skills. Educational leaders can draw upon this method that can be used at schools. The study provided research-based information about how to use and implement the IDEAL method as problem-based learning in the classroom. In addition, this study identified the teaching and learning framework that can complement a 21st-century framework thus creating a culture that believes in preparing students for the 21st century.

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## 2. LITERATURE REVIEW

The IDEAL method in teaching Social Studies is an alternative and constructive approach in creating meaningful and authentic teaching and learning in the classroom replacing lecture-based instruction as a traditional pedagogy. As a result, inappropriate instruction harms the students and is redundant. Instead of being presented in a variety of modes, instruction in Social Studies tends to be abstract, devoid of application, overly sequential. Bits of knowledge are emphasized, not the big picture, thus handicapping global thinkers (Soto, 2012). Accordingly, traditional methods of teaching have been blamed for students' failure to transfer the learned knowledge into real-life situations (Christmas, 2014). Hence, some psychologists condemn the behaviorist perspective that generates situations where the learner is a passive recipient of information. On the contrary, Piaget (1974) believes that the learner must be actively engaged in real learning. Learning is claimed to be progressive when the learner can examine connections between the state-of-the-art knowledge and their preexisting knowledge (Hui & Koplun, 2011; Christmas, 2014).

After all, the traditional method of teaching primarily designs to focus on direct instruction based on textbooks and lectures thus, students learn through listening and observation. However, the IDEAL method as a problem-based learning approach with an extension of “- based learning” will emerge in the Social Studies instruction with its central premise in learning with inmost conceptual understanding or, more commonly, learning with understanding.

For teachers to be able to foster learning with an understanding of diverse students, it is especially important to use a broad repertoire of methods that are visible in its course design/curriculum, teacher and student attitudes, and the classroom-learning environment. In addition, the framework of Social Studies in the 21st century must sharpen the critical and creative thinking skills, which are the key to helping students break down complex 21st-century problems by creating meaningful and authentic Social Studies in the classroom.

Challenging, exciting, and fun, the IDEAL Method offers a sound, methodical approach in creating meaningful and authentic Social Studies. It emphasizes five components of thinking that apply to a wide variety of situations. These include the ability to Identify ideas in the form of good and essential questions, Demonstrate and discuss the good and essential questions, Explore the exploration vehicle of learning, Act of learning, and Lookback for a Long-Term Memory. Note that the first letter of each of these components is found in the word IDEAL but will present the discussion unconventionally. The following are the components of the IDEAL Method:

### 1. Identify ideas in the form of good and essential questions.

The ability to identify ideas in a form of good and essential questions is one of the most important characteristics of successful learning. Putting the focus on students' questions rather than on teacher's questions, and valuing students' questions rather than emphasizing their responses is imperative in supporting learners' higher levels of thinking (Almeida, 2012). It is because teachers must provide students with a feeling of purpose for their learning and

help them intentionally seek information to satisfy their natural curiosity (Isaacs, 2015) by securing them that nothing bad happens when they simply “ask a question” (Nickitas, 2012).

Students’ questions play a significant role in purposeful learning and motivation and can be very compelling about the quality of students’ train of thoughts and conceptual understanding, their alternative frame of reference, and confusion about numerous concepts, their reasoning, and what they want to know (Almeida, 2012).

## **2. Demonstration/ discussion of good and essential questions.**

Once a question has been identified, it must be demonstrated and discussed with more precision. Precisely, good and essential questions generate discussions to provide opportunities for students to demonstrate their knowledge of what they are learning in the classroom, as well as allowing for clarification and expressions of opinion based on their level of understanding.

On the other side, once you determine what students will need to do for each level of understanding, it is time to create a practice that mirrors these levels. This can be accomplished through a variety of strategies and methods by honoring student voice and choice as well as stressing the importance of everyone’s contribution. Generally, the learning content of social studies is about creating knowledge, not memorizing facts but understanding the facts (know what), concepts (know-how), and principles (know why). This is content-specific and authentic-based within a discipline or skill domain.

## **3. Explore the exploration vehicle of learning.**

The ability to identify and demonstrate/discuss the questions or the problems provides no guarantee of successful learning in the classroom. This component is the cardinal in the IDEAL method that will explore a variety of strategies that can help them succeed. Several examples of successful strategies and approaches that can help students stay engaged, show growth, and master the curriculum are provided below.

- a. Explorative learning is generally characterized by students working in groups in some sort of learning and engaging activity to encourage them to examine and investigate in a more in-depth discussion to discover relationships between existing background knowledge and unfamiliar content and concepts.
- b. The differentiated instruction serves as a vehicle for the delivery of a standards-based curriculum to enable teachers to maximize the learning potential of most students, regardless of culture, gender, or background (Tomlinson, et al., 2015). Tomlinson defines differentiated instruction as the efforts of teachers to respond to the variance among learners in the classroom (Inserra, Albert, Short, & Thomas, 2012).
- c. Student-centered learning promotes active (self-) learning. In these processes, teachers serve as companions instead of instructors. It is their vital task to lead the students towards (re-)interpreting the subject matter and thereby “experiencing” its contents (Schröder, 2016).

## **4. Act of learning assessment and Look back for long-term memory.**

The fourth and fifth components of the IDEAL framework are to act based on an assessment strategy and look back at the effects which are developing long-term memory (LTM) after all the acquisition of skills and competencies. Assessment is fundamental to a learner-centered approach to learning, which values distinction, active engagement, and self-management is analytical to learning (Andrade, Huff, & Brooke, 2012).

As mentioned in the above components, integrating all of these meaningfully and authentically will give a long-term memory critical, creative, communicative, and collaborative that is essential in the formation of life-long learning. All of this is in the improvement of proficiency learning. Exquisitely, learners should not progress to later material in a course, except for they have genuinely mastered the earlier material (Kihlstrom, 2013). Certainly, memories may provide an attached reminder of the past, nevertheless, they also allow us to achieve learning objectives and spread out our educational horizons in the here-and-now.

The ultimate goal of using the IDEAL Method in teaching meaningful and authentic Social Studies in the 21st century is to provide the learners with skills for productive problem solving and decision making as well as for assessing issues and making thoughtful value judgments (NCSS, 2009). Above all, integrate these skills and understandings into a framework for responsible citizen participation locally, nationally, and globally (NCSS, 2017). In addition, it will allow them to learn and live in a classroom environment beyond the passport of unique experience and nurturing them to be globally informed but locally grounded in engaging effectively in all transitions in life whatever the challenges

### **2.1. The objective of the study**

The purpose of this study sought to critically look into the following objectives:

1. To investigate whether the IDEAL method as a Problem-Based Learning approach in Social Studies can create an effective teaching process and conducive learning environment.
2. To examine how teachers and students can build general teachers’ high-quality instruction and students’ academic performance in the classrooms.

To encapsulate the above-mentioned objectives, the chief purpose of this study is to take a look at the IDEAL method as a problem-based learning approach as a teaching method and the empirical evidence which backed up its effectiveness, usefulness, applicability, and its instructional impact in the teaching and learning process. The researcher believes that education is a global society that plays an important role to meet the diverse needs of learners and improve their performance levels. Therefore, the teachers, being the focal figure in education are expected to provide learners with the use of premium teaching strategies, approaches, and methodologies to access information, produce new information, and vie with the nouvelle vague.

Indeed, this study provided the best method that demonstrates success in creating effective and productive instruction in Social Studies using the IDEAL method as a problem-based learning approach focusing on the development of 21st-century global skills. Educational leaders can draw upon this method that can be used at schools. The study provided research-based information about how to use and implement the IDEAL method as problem-based learning in the classroom. In addition, this study identified the teaching and learning framework that can complement a 21st-century framework thus creating a culture that believes in preparing students for the 21st century.

## **2.2. Statement of the problem**

This research focused on determining the effect of the IDEAL method as a problem-based learning approach in Social Studies on the students' academic achievement. Therefore, the study raised the primary research questions:

1. What is the performance of the students during the pretest?
2. What is the performance of the students during the posttest?
3. Is there a significant difference in scores from pretest to posttest of the students before and after being taught using the IDEAL method as a problem-based learning approach in Social Studies?
4. What are the implications of using the IDEAL method as a problem-based learning approach in the teaching and learning process in Social Studies?

## **2.3. Hypothesis**

To find solutions to the problem raised, this study hypothesized that:

There is no significant difference in scores from pretest to posttest of the students before and after being taught using the IDEAL method as a problem-based learning approach in social studies?

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## **3. METHODOLOGY**

### **3.1. Research design**

This study identified the central and fundamental study's research question and encouraged investigation of the current study to provide a deep understanding of the effect of the IDEAL method as a PBL approach on students' academic achievement and confirming the usability of the new method in Social Studies. As the underlying purpose of the study is to examine the degree to which a difference may exist between the research questions, the use of a quantitative research method approach was appropriate. Quantitative research is a type of educational research in which the researcher decides what to study, asks the specific, narrow question, collects quantifiable data from participants, analyze these numbers using statistics, and conducts the inquiry in an unbiased, objective manner (Creswell, 2012; Creswell, 2014; Terrell & Edmonds, 2015; Mohajan, 2021).

Quantitative research is used as a statistical technique to understand and explain phenomena. Kumar (2011) states that experimental research involves a study of the effect of the systematic manipulation of one variable on another variable. The manipulated variable is called the experimental treatment or the independent variable (Nurlita, 2011).

The goal of experimental research is to test the hypothesis to establish cause and effect relationships. The ultimate goal of experimental research is to figure out in case a particular approach or way of doing something is "better" than the "older" or more conventional approach that has served as the standard practice (Creswell, 2014). Therefore, this research used an experimental one-group pretest-posttest design to see the result of the treatment. In the pre-test and post-test group, the observation did two times, before giving treatment called Pre-test and after giving treatment called Post-test.

This study was classified as an experimental design because it is little or no control of extraneous variables. In the one-group pretest-posttest design, a single group is measured or observed not only after being exposed to treatment but also before.

The one-group pretest and posttest design usually involved three steps: (a) administering a pretest measuring the dependent variable, (b) applying the experimental treatment X to the subjects, and (c) administering a post-test, again measuring the dependent variable. Differences attributed to the application of the experimental treatment are then evaluated by comparing the pretest and post-test scores (Creswell, 2014).

The procedures of the pre-experimental research with a one-group pretest-posttest design in this research is described as follows (Hendraswari, 2016):

1. Administering a pretest (Y1) was proposed to measure students' academic achievement in Social Studies before being given treatment.
2. Applying an experimental that is using the IDEAL method (X) to teach Social Studies.
3. Administering a posttest (Y2) was proposed to measure students' academic achievement in Social Studies after being given treatment.

Applying one group pretest-posttest, the researcher wanted to find out whether there is any significant difference in students' academic achievement before and after being taught using the IDEAL method as a PBL approach at Bagong Nayon II National High School.

### **3.2. Respondents of the study**

The researcher employed simple random sampling in the present study because it is the purest and the most straightforward probability sampling strategy. It is as well the most suitable method for picking a sample among the population for a wide scope of purposes. In simple random sampling, each

representative of the population is coequally in all probability to be selected as part of the sample. It has been stated that “the rationale behind simple random sampling is that it eliminates bias from the method of selection and should result in representative samples (Business Research Methodology, 2011; Ama, 2020; Aborah-Osei & Danso, 2021).

In order to obtain the required respondents and to minimize the relevance of bias in the process of simple random sampling selection, the method of the lottery was used and it involved the following stages:

1. The researcher prepared a list of all members of the population.
2. The researcher had to number each member of the population in a consequent manner, writing numbers in separate pieces of paper. These pieces of papers were folded and mixed into a box (Simsek & Erdogan, 2020).
3. Lastly, samples were taken randomly from the box by choosing folded pieces of papers in a random manner.

As a deduction, the study used sixty (60) respondents, Grade Ten (10) students at Bagong Nasyon II National High School, Academic Year 2018-2019. The sixty (60) respondents of this research will be part of the study group applying the IDEAL method as a PBL approach as the independent variable to measure the students’ academic achievement as the dependent variable.

### 3.3. Data gathering procedures

The researcher first sought permission from the Schools Division Superintendent to conduct the study. Upon approval, the researcher asked permission from the Principal of Bagong Nasyon II National High School to conduct the study among the Grade Ten (10) students. The experimental research design is known as one group pretest and posttest (Ary, 2013; Mertens, 2014) was adopted to conduct the investigation. The study was completed with sixty (60) respondents, Grade Ten (10) students at Bagong Nasyon II National High School in the Division of Antipolo City.

The study was carried out for one week during which the students were taught using the IDEAL method as a PBL approach. The researcher, in the role of “teacher-researcher”, was directly involved in all phases of the study, from planning, designing, implementation, and evaluation; hence exerted greater control over the research process that helped in reducing the effects of extraneous factors on the study. As for the planning and designing, the researcher chose the place of the study, gave information for the instance that related to show this study, made instrument try out, showed the try out the class that has been determining, and the researcher analyzed try out. For the implementation of the research study, the researcher gave the treatment and test (pre-test and post-test) about *mgakarapatangpantao* (human rights) until five meetings. Finally, for the evaluation, the researcher gave the test to the students, calculated the result of the test, and put the data in the table. On the other hand, participants of the study, i.e., students were informed about the study, and their consents were obtained prior to the commencement of the research.

### 3.4. Data analysis

A paired sample t-test was used to compare student responses before and after being taught by using the IDEAL method. The t-test was served to identify differences between the pre-test and post-test responses on the instrument. The t-test was run on student responses to the pretest and posttest academic achievement results. The results were analyzed to determine whether the results are statistically significant. All data were entered into Microsoft Excel, and all statistical analyses were conducted at a 0.05 alpha level.

### 3.5. Ethical considerations

In this study, ethical issues were considered when carrying out the study as all the research participants were informed about the purpose of the investigation and the features of the research design. Informed consent was obtained from individual teachers and students. The researcher ensured that confidentiality and anonymity are employed in which the information collected was strictly used for research purposes. More so, the identities of teachers and students are not disclosed.

## 4. RESULTS

### Problem No. 1. What is the performance of the students during the pretest?

Test result. Table 1 shows the performance of the students during the pretest.

**Table 1 - Performance of the students during the pre-test.**

Score	N	Percentage
10	3	5.0%
12	2	3.3%
13	1	1.7%
14	7	11.7%
16	1	1.7%
17	3	5.0%
18	2	3.3%
19	8	13.3%
20	5	8.3%
21	8	13.3%

22	1	1.7%
23	4	6.7%
24	5	8.3%
25	4	6.7%
26	1	1.7%
27	1	1.7%
28	1	1.7%
30	3	5.0%
<b>Total</b>	<b>60</b>	<b>100%</b>
<b>Mean</b>	<b>19.88</b>	
<b>SD</b>	<b>4.98</b>	

As revealed in Table 1, the means score was 19.88. The mean of 19.88 meant that the average of sixty (60) students score 19.88. So, the student's score of 19.88 was an average score, with a standard deviation of 4.98.

This manifested that the mean score of the pretest was higher than the standard deviation. The standard deviation of 4.98 for the pretest indicated more dispersed scores in a one-group pretest and posttest experimental study. This means that only a few students had basic ideas about *mgakarapatangpantao* (human rights), thus the students who took the pretest were appropriate as respondents for the research study.

The present study was having a similar response as that of Shivaraju, Manu, and Saykar (2017) suggesting that pre-tests can have orienting and motivational and (hence) teaching functions — in addition to the sought-for testing function and concluded that the pretest did not result in a measurable increase in learning. The study did demonstrate that the teaching method was effective as post-instructional knowledge increased by nearly half when compared with pretest levels (Charan, 2017).

The results of the present study were supported by the earlier study conducted by Salle, Edgar, and Johnson (2013) on “The Effects of Problem-Based Learning on Students' Performance in Social Studies”. The sample size was sixty (60) students from the secondary school, Vadodara district, Gujarat, India. The pre-experimental design was used. The pretest means score, were calculated at 15.40, with a standard deviation of 4.085. Data collected similar to the present study indicated knowledge held is low thus demonstrating the need for the students to undergo treatment using the IDEAL method as a PBL approach in social studies.

#### Problem No. 2. What is the performance of the students during the post-test?

Test result. Table 2 shows the performance of the students during the posttest.

**Table 2 - Performance of the students during the post-test.**

Score	N	Percentage
20	1	1.7%
30	4	6.7%
33	3	5.0%
34	2	3.3%
35	2	3.3%
36	2	3.3%
37	4	6.7%
38	10	16.7%
39	3	5.0%
40	8	13.3%
41	5	8.3%
42	2	3.3%
43	3	5.0%
44	2	3.3%
45	5	8.3%
47	3	5.0%
48	1	1.7%
<b>Total</b>	<b>60</b>	<b>100%</b>
<b>Mean</b>	<b>38.90</b>	
<b>SD</b>	<b>5.07</b>	

As shown in the data, the means score was 38.90. The mean of 38.90 meant that the average of sixty (60) students score 38.90. So, the student's score of 38.90 was an average score. Meanwhile, the standard deviation was 5.07.

The findings indicated that those taught using the IDEAL method as a PBL approach increased their scores from a mean of 19.88 in the pre-test to a mean of 38.90 in the post-test, an increase of 19.02 was observed.

Similar to the study of Baysal (2017), learning to be effective requires the ability of the teacher to arouse and sustain the interest of the students. He/she needs to motivate the students to produce a better teaching and learning process.

Findings of the present study agreed with the finding of Yaduvanshi and Singh (2018) which revealed that Problem-Based Learning (PBL) approach significantly improve the performance of the students after given a treatment. The improvement of the posttest conducted by the researcher is due to the reason that the IDEAL method which was largely based on the PBL approach classroom creates a harmonious and pleasant learning environment for

students and positively motivates them. When the students are working in such a cooperative and collaborative environment, the learning process becomes interesting and enjoyable. Therefore, students who got low scores in the pretest take interest in the academic task and actively participated in learning activities using the IDEAL method as a PBL which contributes toward their success. In the present study, it was reported that on the posttest, the scores of the students significantly improved. In addition, the researcher observed that all students showed interest during the treatment process using the IDEAL method as a PBL approach.

**Problem No. 3. Is there a significant difference in scores from pretest to posttest of the students before and after being taught using the IDEAL method as a problem-based learning approach in social studies?**

The result of the percent of increased both from pretest and posttest of one group experimental were presented on the table below:

**Table 3.1–Percent of increased from pre-test to post-test.**

Pre-test Scores	Post-test Scores	Increased	Percent of Increased
19.88	38.90	19.02	96%

It can be gleaned from the data that the mean score of pre-tests was 19.88, while the mean score of post-tests was 38.90 with an increase of 19.02. It signifies that after the students were given treatment, the percent of increased from pretest to posttest was 96%.

The result of the present study was supported by the earlier study conducted by Huang and Wang (2012) about “Applying Problem-Based Learning in Classes”. The conclusions of this study provided factual implications for the applicability and possibility in the implementation of PBL in classes. Based on the responses and the self-reported comments given, a greater number of participants responded positively vis-a-vis the utilization of PBL in teaching. Especially, students’ motivation and self-achievement have both reached a significant level. Students revealed that in the PBL class environment, they were not only motivated and exhilarated by learning synchronically and cooperatively, but also developed a collectible union of friendship (Huang & Wang, 2012). This PBL learning atmosphere could stimulate students’ creativity that helped them improve their skills effectively. The result of the present study has suggested the successful implementation of the IDEAL method in class since this instructional method was entirely based on the problem-based learning (PBL) approach, the teacher may consider incorporating the IDEAL method as a PBL approach in their teaching to elevate students’ abilities.

In their study titled “A Qualitative Evaluation of the Problem-Based Learning,” Biberci and Baser (2012) aimed to define the opinions of students regarding the process where PBL was used in social studies classes. At the end of the study, it was found that the PBL process enhances collaboration, communication, problem-solving, and research skills (Mohamad, et al., 2021). Their findings are compatible with the findings of the current study in that they concluded that the learners enjoy learning in this approach in cooperation with the IDEAL method that the research used in the present study, thus, optimizing the development of the Four Cs like the 21st-century global skills such as critical thinking and problem solving, communication, collaboration, and creativity and innovation. On the other hand, the researcher used a statistical test with a paired t-test to convince of pretest and posttest of the effectiveness, applicability, and instructional impact of using the IDEAL method as a problem-based learning approach in Social Studies. The result is as follows:

**Table 3.1–The difference of the scores of the students from pre-test to post-test.**

Computed Paired t-test Value	Sig. (p-value)	Interpretation	Decision
-37.736	p<0.0005	Significant	Reject the Null Hypothesis

*Note: p-value  $\leq 0.05$  - significant, p-value  $> 0.05$  - not significant*

Table 3.2 above showed the result of the analysis using a T-test. The computed paired t-test value was -37.736 and the significance (p-value) was  $p < 0.0005$ . With the numerical significant value  $0.0005 \leq$  than significant level 0.05, then the hypothesis null stated that there is no significant different score in the level of academic achievement of the students before and after being taught using the IDEAL method as a problem-based learning approach in social studies was rejected.

Based on the statistical calculation, the researcher gave an interpretation to a significant value. The significant value of the research was 0.0005 and the significant level of 0.05. When the significant value ( $0.0005 \leq$  significant level (0.05) the null hypothesis ( $H_0$ ) was rejected. Because the significant value (0.0005) was smaller than the significant level (0.05), it can be concluded that the null hypothesis ( $H_0$ ) was rejected. It means that there is a different score on the students’ academic achievement before and after being taught by using the IDEAL method as a problem-based learning approach in social studies. There was a difference on Paired Sample Statistic that the mean before taught using the IDEAL method as a problem-based learning approach is 19.88, and after being taught using the IDEAL method as a problem-based learning approach was 38.90, it means that the mean before being taught using the IDEAL method as a problem-based learning approach was lower than after being taught using the IDEAL method as a problem-based learning approach. Thus, it can be concluded that the IDEAL method as a problem-based learning approach is effective, applicable, and have an instructional impact on the students’ academic achievement in the tenth grade of Bagong Nayon II National High School.

The result supported the findings of Rahman, et al. (2016) where the results concluded that the post-test means score of students after being taught using PBL was higher than the pretest mean score of the students before being taught using PBL. Therefore, there was a significant difference in the average

scores of both pretest and posttest. The results of the study revealed that the one group taught with PBL performed better which indicated the usefulness of PBL in teaching Social Studies at the secondary level.

Another study conducted by Fatade (2013) on fifty-four (54) students who were taught using PBL found a significant mean difference in the achievement of mathematics post-test scores of students. Similar to the present study conducted by the researcher, through the stages in the IDEAL method as a PBL approach, students can improve learning achievements that include conceptual understanding, reasoning, and problem-solving. This is consistent with the results of research by Ajai (2013) to four hundred and a forty-seven senior secondary one that PBL to improve student learning achievements on Social Studies.

#### **Problem No. 4. What are the implications of using the IDEAL method as a problem-based learning approach in the teaching and learning process in social studies?**

The process of learning requires that the learner actively participates in creative activities and self-organization. The IDEAL method as problem-based learning is a constructivist, student-centered instructional strategy in which students within a constructivist learning environment play a more active role in, and accepts more responsibility for their learning. The present study grounded on the theory of constructivism by Vygotsky (1934) and Bruner (1996) describes how students and their teacher interact; How to use classroom time and space, and how to balance classroom control between teachers and students. Constructivism assumes that learning is made possible through the dual factors of social interaction and simultaneous exposure to cognitive experiences (Brown, 2018). In addition, constructivism creates an atmosphere where teachers and students share responsibilities, thereby sharing power and control among all members of the classroom. Students are given the necessary structure, voice, time, and space to question, explore, and argue to make sense of phenomena and concepts. There is an interaction between teacher and students and student-student, which are considered equally important in the learning process. The roles and responsibilities of students and teachers are seamlessly transferred between the two parties. Although teachers are fully responsible for creating an environment conducive to learning, they are also jointly responsible for creating and responding to the learning environment.

Therefore, as a constructivist pedagogical approach, the IDEAL method as a PBL has several clear implications in the teaching and learning process such as increased retention of information, an integrated (rather than discipline bound) knowledge-based, the development of lifelong learning skills, and exposure to real-life experiences at an earlier stage in the curriculum, increased student-teacher interactions, and an increased in an overall motivation that has been identified in this study. Self-Study and group discussions develop competence, in addition to self-directed learning, multidisciplinary knowledge formation, and interdependent skills. The entire process of the IDEAL method is very interactive, achieving the goal of student engagement in learning, which has been shown to improve retention and satisfaction. Hence, it was surprising that this study has revealed a high level of students' academic achievement with this learning technique.

On top of the implications, the sum and substance of this study are that when the students can find their concepts by studying in groups (student-centered learning) with teacher guidance (as facilitator), students do not need to memorize many facts in social studies. This is useful because students do not easily forget the concepts they have learned. Because the IDEAL method as a PBL incorporates cooperative learning and exploratory learning with the integration of differentiated instruction and activities, learning through a group work system has several advantages. The advantages of a student working in groups are that students perform better on standardized tests than with students working individually (Nikmah, 2018).

Therefore, students engaged in the IDEAL method as a PBL had better knowledge acquisition in the aspect of principles and procedures. This result signifies that at present-day, the method of instruction should focus on the application of knowledge or "know-how" or "know-why", rather than focusing on "know-what". The ability to apply knowledge is one of the necessary prerequisites to improve competencies in the 21st-century global environment. In this capacity, the IDEAL method can enhance students' ability to apply the knowledge that was proven in this study.

Primarily based on the theory of constructivism, the IDEAL method as a problem-based learning approach demonstrated that students are capable of accepting responsibility to take charge of their learning; those students are willing to be responsible and responsive, and those students who are entrusted to learn will develop the essentials of intrinsic motivation and self-confidence to continue as independent learners.

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## **5. DISCUSSION**

As mentioned previously, the researcher wanted to know whether there was a different score between the students before and after teaching by using the IDEAL method as a problem-based learning approach in social studies. In this study, the researcher did experimental research about the effectiveness of IDEAL method as a problem-based learning approach toward students' academic achievement of Grade Ten (10) at Bagong Nasyon II National High School. The researcher involved a class consisted of sixty (60) students. The data were collected through administering the test. The first test was pre-test done before the treatment applied to the students. The purpose was to know the students' performance before the treatment. The result of pre-test showed that their competencies and mastery was poor. They got difficulty to answer the questions given to them.

After administering the pre-test, the researcher gave treatment to the students by using the IDEAL method as a problem-based learning approach. During the treatment, the students enjoyed learning and they were enthusiastic to engaged and actively participated in all phases of learning. When treatment was finished, the researcher administered posttest to know the students' performance after being taught by using the IDEAL method as a problem-based learning approach. Apparently, the result of the post-test showed that the students' competencies and mastery improved significantly.

Among the important findings of this research were:

1. A significant difference between pre-test and post-test score in a one group experimental was observed and this indicated that the IDEAL method as a problem-based learning approach could be an effective methodology for teaching social studies and this methodology could be used to teach social studies at Bagong Nasyon II National High School. Post-test scores showed a significant difference in their mean



achievement. This evidence further strengthens the findings that IDEAL method as a problem-based learning approach can facilitate students' achievement and learning better to teach social studies.

2. The study showed that students exposed to instruction with the IDEAL method as a PBL approach had higher posttest mean score that signifies a significant positive predictor of developing Four Cs as a 21st-century global skills such as critical thinking and problem solving, communication, collaboration, and creativity and innovation. Several studies on PBL promotes collaborative learning (Asghar, Ellington, Rice, Johnson & Prime, 2012), develop content knowledge (Yew & Goh, 2016), and enhances critical thinking skills. In this study, it was indicated that the IDEAL method as a PBL approach improved test scores of the students in the posttest test. Thus, social studies teachers should incorporate the IDEAL method as a PBL approach into the curriculum for the development and enhancement of the Four C's as 21st century global skills.
3. Based on the results and discussion of the research, it can be concluded that there was an increase in the learning academic achievements of the tenth-grade students on learning using the IDEAL method as a PBL approach on the subject matter of *mgakarapatangpanato* (human rights). The improvement of students' learning academic achievement of the posttest was higher than the pretest, so it can be concluded that the application of the IDEAL method as a problem-based learning model which in student-centered learning can be superior in improving student learning academic achievement. Providing with group learning systems also makes students more able to engage in different activities creatively and among group members can support each other in doing the differentiated activities and instructions successfully. Therefore, it can be concluded that the application of the IDEAL method as a problem-based learning approach can improve student learning academic achievement.

Therefore, the major finding of the study reveals that the IDEAL method as a PBL approach is effective for teaching social studies. By adopting the IDEAL method as a PBL approach in teaching social studies teacher can create a number of creative thinkers, critical decision makers, and problem solvers which is very much needed for the competitive world. And also, an IDEAL method as a learning instructional strategy had an effect on content knowledge which provides greater opportunities for the learners to learn content with more involvement and increase the student's active participation, motivation and interest among the learners. This leads the learners to have a positive attitude towards social studies and help them to increase their academic achievement to a large extent and which will lead to long term memory. It gave a new and desirable kind of experience for the students.

## 6. CONCLUSIONS

The purpose of this research study was to determine the effectiveness and applicability of incorporating the IDEAL method as a problem-based learning approach in the teaching and learning of Social Studies. The finding reported in this study illustrate a positive impact on the students' development in their understanding of Social Studies content knowledge. Through the use of the IDEAL method as a PBL, the results showed an improved performance in the post-test as students displayed high order thinking skills in applying the knowledge learned in lessons to answer questions satisfactorily. Their performance revealed good comprehension of the contents with detailed analysis and application of information. Additionally, students' engagements during the different activities were encouraging with signs of progress in behavioral, psychological, and cognitive engagements observed in their learning process. The students were motivated in carrying out independent inquiries and the interactive nature of class discussion can be attributed to their appreciation of the learning activity. Their increased perception of the learning environment during lessons further reinforces their understanding of the subject.

Primarily, the study focused on the IDEAL method as a PBL approach to teaching grade ten junior high school students as a modern and interactive method of teaching Social Studies to learners at Bagong Nayon II National High School. Using the one-group pretest and posttest experimental design the data is compared to study the impacts of the IDEAL method as a PBL approach on students' performance on the curricular content. The study suggests the IDEAL method as a PBL approach as a means to promote students' active involvement in learning, historical skills development, use of learner-centered strategies, and learning resources that upshot in developing students' academic achievement, skills intensification, motivation, and self-determination. The study confirmed that by employing the IDEAL method as PBL approach teachers and students can achieve their teaching-learning goals in Social Studies within the existing setup and keeping the constraints of the context in view. The experiment helped in changing learners' perceptions and attitudes about Social Studies and brought about a positive change in the classroom environment. A major study outcome produced an opportunity for students for collaboration, engagement and motivation, critical thinking and problem-solving skills, information collection, analysis and synthesis, and critiquing self and others. The students graduating from junior high school were able to practice these skills through the use of the IDEAL method as a PBL that is needed for their further education and career in senior high school and tertiary education.

Therefore, the results from the study showed that when students are exposed to the IDEAL method as a PBL approach there is an improvement in achievement in their scores. Therefore, the IDEAL method as a problem-based learning approach could be used as a means of enhancing student engagement, student learning, critical thinking, and self-reflection. The research presented here clearly shows that the IDEAL method as a PBL is a pedagogical approach that affords teacher educators opportunities to meet the demands of 21st-century educational reform. Teachers are marked to have methodical content and disciplined knowledge and to engage in constructing, evaluating, and problem-solving. Equally important, they will be expected to work with other teachers and their students to jointly address learner and pedagogical issues; to work as team members and collaborators; and to develop themselves as self-reflective, self-directed, and lifelong pedagogues.

It is hereby concluded in this study that the IDEAL method as a problem-based learning approach is more effective than the conventional lecture method in improving students' achievement in Social Studies and that the use of the IDEAL method as a problem-based learning approach is the solution to the dwindling performance of students in Social Studies.

## 7. RECOMMENDATIONS

In light of the conclusions drawn from the study, the following are hereby recommended:

1. For further studies, it is recommended to use the IDEAL method as a problem-based learning approach in other social studies subjects such as ASEAN history, world history, and economics to see a more holistic perspective on the effects of the IDEAL method as a PBL in developing 21st-century global skills.
2. To allow longer time in studying the effects of the IDEAL method as a PBL approach in other lessons in social studies 10 contemporary issues for more thorough results.
3. To increase the sample size of student-participants for more reliable findings.
4. The present study was carried out at just one institution comprising grade ten only population, hence the study needs to be carried out at more public secondary high schools with other grade level populations in order for the study findings to be generalized.
5. To identify problems encountered by the teacher, students, and researcher to determine hindrances and barriers in the implementation of the IDEAL method as a PBL approach in secondary education.
6. Continuous seminars, workshops, and further retraining of teachers are needed to improve and upgrade their methods and strategies of teaching.
7. A parallel study using the teachers as participants is highly recommended.

## REFERENCES

- Aborah-Osei, C. & Danso, H. (2021). Factors affecting the delivery of building construction projects funded by District Assemblies Common Fund (DACF): the case of selected regions in Ghana. *West Africa Built Environment Research (WABER) Conference WABER*. Retrieved from [https://www.researchgate.net/publication/353803481\\_Factors\\_affecting\\_the\\_delivery\\_of\\_building\\_construction\\_projects\\_funded\\_by\\_District\\_Assemblies\\_Common\\_Fund\\_DACF\\_the\\_case\\_of\\_selected\\_regions\\_in\\_Ghana](https://www.researchgate.net/publication/353803481_Factors_affecting_the_delivery_of_building_construction_projects_funded_by_District_Assemblies_Common_Fund_DACF_the_case_of_selected_regions_in_Ghana).
- Ajai, J. T. (2013). Comparison of the learning effectiveness of problem-based learning and conventional method of teaching social studies. *Journal of Education and Practices, 4*(1).
- Almeida, P. A. (2012). Can I ask questions? The importance of classroom questioning. *Procedia - Social and Behavioral Sciences 31*:634-638. DOI: 10.1016/j.sbspro.2011.12.116.
- Ama, L. N. (2020). Impact of climate change on the variations of non-traditional forest products in the Birim Central Municipality, Ghana. *International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS) Vol. 7, Issue 4*, pp: (12-19). Retrieved from <https://www.paperpublications.org/upload/book/paperpdf-1607764430.pdf>.
- Andrade, H., Huff, K., & Brooke, G. (2012). *Assessing learning*. The Education Digest, 78.3, 46-53. Retrieved from [https://jfforg-prod-new.s3.amazonaws.com/media/documents/Exec\\_AndradeHuffBrooke\\_032312.pdf](https://jfforg-prod-new.s3.amazonaws.com/media/documents/Exec_AndradeHuffBrooke_032312.pdf).
- Ary, D. (2013). *Introduction to research in education*. 9th ed., Wadsworth Cengage Learning, Belmont.
- Asghar, A., Ellington, R., Rice, E., Johnson, F., & Prime, G. M. (2012). Supporting STEM Education in Secondary Science Contexts. *Interdisciplinary Journal of Problem-based Learning, 6*(2). <http://dx.doi.org/10.7771/1541-5015.1349>.
- Baysal, Z. N. (2017). The problem-based learning: reflections of secondary students. *Academic Journal, Vol. 12 (4)*. Retrieved from <http://www.academicjournals.org/ERR>.
- Biberici, M. & Baser, N. (2012). *A qualitative evaluation of problem-based learning*. Hasan Ali Yucel Faculty Educ. Magazine 17 (1).
- Brown, L. (2018). *Constructivist Learning. Pedagogy in Action: the SERC portal for Educators*. Retrieved from <https://serc.carleton.edu/sp/library/sac/constructivist.html>.
- Business Research Methodology (2011). *Simple random sampling*. Retrieved from <https://research-methodology.net/sampling-in-primary-data-collection/random-sampling/>.
- Charan, D. (2017). Evaluating the effectiveness of pre- and post-test model of learning in a medical school. *The Free Library*. Retrieved from <https://www.thefreelibrary.com/Evaluating+the+effectiveness+of+pre+and+post+test+model+of+learning...+a0508201458>.
- Christmas, D. (2014). Authentic pedagogy: implications for education. *European Journal of Research and Reflection in Educational Science*. Vol. 2, No. 4.
- Creswell, J. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Upper Saddle River, NJ: Pearson Education.
- Creswell, J. W. (2014). *Research design: qualitative, quantitative, and mixed methods approach*. SAGE Publications, Inc.
- DepEd (2015). *Numeracy and literacy program*. Retrieved from <http://www.deped.gov.ph/orders/do-12-s-2015>.
- Fatade, A. O. (2013). Effect of problem-based learning on senior secondary school students' achievement in further mathematics. *Acta Didactica Napocensia, 6* (3).
- Hendraswari, M. (2016). *Chapter III Research method*. Retrieved from <http://repo.iain-tulungagung.ac.id/4272/4/CHAPTER%20III.pdf>.
- Huang, K.S. & Wang, P. S. (2012). Applying problem-based learning (PBL) in classes. *The Journal of International Management Studies*, Vol. 7, No. 1.
- Hui, F., & Koplin, M. (2011). The implementation of authentic activities for learning: a case study in finance education. *e-Journal of Business Education and Scholarship of Teaching*, Vol 5, Iss.1. 59-72.
- Inserra, Albert, Short, Thomas (2012). An Analysis of High School Math, Science, Social Studies, English, and Foreign Language Teachers' Implementation of One-to-One Computing and Their Pedagogical Practices. *Journal of Educational Technology Systems*, Vol. 41; Iss. 2. DOI: 10.2190/et.41.2. d.
- Isaacs, L. (2015). Using an anchor text to spark inquiry asking questions and conducting a meaningful investigation. *National Council of Teachers of English*, Vol. 23, No. 1.
- Joerges, B. & Nowotny, H. (2012). *Social studies of science and technology: looking back, ahead*. Springer Science & Business Media. Retrieved from [https://books.google.fr/books?id=14tqCQAAQBAJ&printsec=frontcover&hl=fr&source=gbs\\_ge\\_summary\\_r&cad=0#v=onepage&q&f=false](https://books.google.fr/books?id=14tqCQAAQBAJ&printsec=frontcover&hl=fr&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false).

- Kihlstrom, J. F. (2013). *How Students Learn -- and How We Can Help Them*. Department of Psychology, University of California, Berkeley. Retrieved from [https://www.ocf.berkeley.edu/~jfkihlstrom/GSL\\_2011.htm](https://www.ocf.berkeley.edu/~jfkihlstrom/GSL_2011.htm).
- Kumar, R. (2011). *Research methodology: a step-by-step guide for beginners*. SAGE Publications, Inc.
- Mertens, D. M. (2014). *Research and evaluation in education and psychology, integrating diversity with quantitative, qualitative, and mixed methods*. SAGE Publications, CA.
- Mohajan, H. K. (2021). Quantitative Research: A Successful Investigation in Natural and Social Sciences. *Journal of Economic Development, Environment and People*, 9(4). doi: <http://dx.doi.org/10.26458/jedep.v9i4.679>.
- Mohamad, et al. (2021). Self-evaluation in problem-based learning. Universiti Kebangsaan Malaysia, Malaysia. *AJTLHE* Vol. 3, No.1, 50-57. Retrieved from [https://www.researchgate.net/publication/265353491\\_SELF-EVALUATION\\_IN\\_PROBLEM-BASED\\_LEARNING](https://www.researchgate.net/publication/265353491_SELF-EVALUATION_IN_PROBLEM-BASED_LEARNING).
- NCSS (2009). *Powerful and Purposeful Teaching and Learning in Elementary School Social Studies*. Social Education, v73 n5 p252-254. Retrieved from <https://eric.ed.gov/?id=EJ864078>
- NCSS (2017). *A Position Statement of the National Council for the Social Studies*. Retrieved from <https://www.socialstudies.org/position-statements/powerful-purposeful-pedagogy-elementary-school-social-studies>.
- Nickitas, D. M. (2012). Asking a question and appreciating inquiry: a winning strategy for the nurse education and professional nurse learner. *The Journal of Continuing Education in Nurses*, Vol. 43, No. 3.
- Nikmah, I. L. (2018). The Implementation of problem-based learning to improve students' learning achievements. *International Education and Resource Journal*, Vol. 4, Issue 3.
- Nurlita, SD. (2011). *Chapter III research method*. Retrieved from <http://repo.iain-tulungagung.ac.id/1450/3/CHAPTER%20III.doc>.
- Rahman, M. A. et al. (2016). The Impacts of 'Problem-Based Learning' Approach in Enhancing Critical Thinking Skills to Teaching Literature. *International Journal of Applied Linguistics and English Literature*. DOI: <http://dx.doi.org/10.7575/aiac.ijalel.v5n.6p.249>.
- Sadruddin, M., & Wahab, Z. (2013). Are we preparing globally competent teachers? - Evaluation of the incorporation of global education perspectives in the teacher education curriculum in Pakistan. *Bulletin of Education and Research*, Vol. 35, No. 1 pp. 75-94.
- Salle, C. W., Edgar, D. W., & Johnson, D. M. (2013). Student Perceptions of Instructional Methods Towards Alternative Energy Education. *Journal of Agricultural Education*. Volume 54, Number 2, pp. 130 –142. DOI: 10.5032/jae.2013.02130.
- Schröder, M. (2016). Student-centered learning (SCL) latest trend or an integral part of good teaching. *Foundation for International Business Administration*. Retrieved from [http://www.fibaa.org/uploads/media/19\\_Werkstatt\\_SCL\\_EN.pdf](http://www.fibaa.org/uploads/media/19_Werkstatt_SCL_EN.pdf).
- Shivaraju, PT. S., Manu, G., & Saykar, M. K. (2017). Evaluating the effectiveness of a pre-and post-test model of learning in a medical school. *National Journal of Physiology, Pharmacy, and Pharmacology*. Retrieved from <http://www.njppp.com/fulltext/28-1492680142.pdf>.
- Simsek, Z. C. & Erdogan, N. I. (2021). Comparing the effects of different book reading techniques on young children's language development. *Read Writ* 34, 817–839 (2021). <https://doi.org/10.1007/s11145-020-10091-9>.
- Soto, A. (2012). *Understanding 'understanding'* (Why DepEd did not succeed in its adoption of the UbD). Retrieved from <http://www.headlinegl.com/understanding-understanding-why-deped-did-not-totally-succeed-in-its-adoption-of-the-ubd/>.
- Terrell, S. R., and Edmonds, W. A. (2015). *Mixed-Methods Research Methodologies*. Graduate School of Computer and Information Sciences, Nova Southeastern University. Retrieved from [https://education.nova.edu/summer/2017sessionmaterials/Elective\\_Mixed-Methods\\_Edmonds\\_Terrell.pdf](https://education.nova.edu/summer/2017sessionmaterials/Elective_Mixed-Methods_Edmonds_Terrell.pdf).
- Tomlinson, et al. (2015). *Assessment and student success in a differentiated classroom*. Professional Learning Services. Retrieved from <http://www.ascd.org/ascd/pdf/siteascd/publications/assessment-and-di-whitepaper.pdf>.
- UNICEF (2000). *Defining quality education*. The International Working Group on Education Florence, Italy. Retrieved from <https://www.unicef.org/education/files/QualityEducation.PDF>.
- Wood, B., Milligan, A., & Morgan, J. (2013). Emerging issues and research in New Zealand social science education. *New Zealand Journal of Educational Studies*. Vol. 48, No.2.
- Yaduvanshi, A. & Singh, S. (2018). Effect of Informal Cooperative Learning Strategy in Biology Achievement on Learners of Diverse Ability. *The Online Journal of New Horizons in Education*. Volume 8, Issue 3.
- Yew E.H.J, Goh K. (2016). *Problem-based learning: an over view of its process and impact on learning*. Health Professions Education. <http://dx.doi.org/10.1016/j.hpe.2016.01.004>.