WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Empowering Critical Thinking Skills by Implementing Scientific Approach-Based Models

Margie I. Paulino [a]

Senior High School Teacher II, Salapungan National High School, Philippines[a]

A B S T R A C T

This study determined the effect of using scientific approach-based models on Earth and Life Science in enhancing the critical thinking skills of Grade 11 students in Salapungan National High School, San Rafael Bulacan during the School Year 2023 – 2024. With explanatory sequential mixed methods as research design and 108 Grade 11 students as respondents of the study, findings showed that the Grade 11 students' critical thinking skills in Earth and Life Science before exposing them to traditional approach, problem-based learning and guided inquiry was described as "below average." After conducting the experiment, the Grade 11 students' critical thinking skills in Earth and Life Science after exposing them to traditional approach was described as "average." On the other hand, the Grade 11 students' critical thinking skills in Earth and Life Science after exposing them to problem-based learning and guided inquiry was described as "above average." Based on the findings of the study, these conclusions were drawn: Traditional, Problem-Based Learning, Guided Inquiry approaches are effective in teaching Earth and Life Science to develop critical thinking skills. PBL approach is the most effective and the least effective is the traditional approach in teaching Earth and Life Science to develop critical thinking skills among Grade 11 students.

Keywords: Critical Thinking Skills, Guided Inquiry, Earth and Life Science, Problem-Based Learning

Introduction

In today's rapidly evolving world, the ability to think critically is more important than ever before. As students navigate a complex and interconnected global society, they must be equipped with the skills to analyze information, evaluate evidence, and form reasoned judgments. Empowering critical thinking in students has become a paramount goal for educators and researchers alike, as it enables them to become independent thinkers and active participants in their own learning process. Students who received specific instruction in critical thinking demonstrated improved decision-making skills, which led to more thoughtful and rational choices in various contexts.

The low student achievement in Science of Filipino students did not come as a surprise to Philippine education. Local studies have long documented this science education dilemma. The latest 2018 Programme for International Student Assessment (PISA) result shows that Filipino students' Mathematical and Scientific Literacy falls below the average standard set by the Organization for Economic Cooperation and Development (OECD). Department of Education (DepEd), as the primary basic education institution of the country, is very keen on recognizing the relevance of the result of PISA and TIMSS's. In its official statement, the institution (DepEd) has assured the public of its introspection into the gaps and issues hindering the acquisition of the quality basic education of the country. This international assessment results provide a fertile ground for introspection by educational researchers, practitioners, and policymakers. It is important to note that a comparison between the international competencies measured by TIMSS and the local competencies as stipulated by the K-12 curriculum showed remarkable disparity (Balagtas, et.al., 2019).

The Department of Education (DepEd) in the Philippines, has integrated the 21st-century skills into its K to 12 reform agenda. Test items had also been developed and incorporated into National Achievement Tests (NAT) for these skills to be aligned with the learning goals of the K to 12. As in other countries, transversal competencies are not taught independently but embedded in the various subjects of the curriculum. It indicates that an extensive range of the skills is being taught and assessed by Philippine teachers. One of the challenges reported by teachers and administrators in the Philippines was the shortage of other assessment materials designed to target transversal competencies. Furthermore, other problems encountered were uncertainty regarding the definition of skills, lack of technical expertise in teaching and assessing the skills, and curriculum pressure to focus on the content of subject areas (Saldo & Walag, 2020).

Developing students' full potential is one of the significant responsibilities of a teacher. Teacher's responsibility is not only limited to the four walls of the classroom or the compensation they received but on the level of students' learning of the necessary skills and on how they apply it on their daily living and in bridging their journey to success. Like the schools in other countries, one of the primary goals of the Philippine education system is to develop students' 21st-century skills such as communication and collaboration. As shown in the NAT results reported, science had the lowest mean percentile score among other subjects. This goes to show that much should be done to improve the state and quality of science education in the Philippines. To achieve this, the government must impose a change in how educators should teach the learners in today's generation. It has been suggested that Problem-

based Learning (PBL) and Guided Inquiry (GI) be used. These methods are of great advantage to propel the class towards interactive learning and change the course of teaching and learning from the traditional classroom practices into a much more modern and exciting environment (Digal and Walag, 2019).

Problem-based Learning (PBL) in its most highly developed form is an approach to curriculum design and implementation rather than teaching strategy or method. This approach to teaching and learning was first applied and utilized in the field of medicine. When it was proven effective to medical students, several attempts were made to apply it in another field like teaching. A PBL curriculum is designed around a comprehensive, real and complex problems that provide learners with opportunities to acquire the knowledge, understanding and skills that are defined by the curriculum outcomes. In its deepest sense, the problem is the curriculum which is the stimulus for each aspect of student's independent learning. The use of problem solving is based on the premise that sustained exposure with appropriate set of problems will help learners to acquire a substantial knowledge base, deepen their understanding of important concepts and principles, and develop skills (problem-solving skills and interpersonal skills) that are relevant to their future careers (Killen, 2007 as cited by Valdez and Bungihan, 2019).

Additionally, Iriani et al., (2019) reported that the PBL model in learning activities encourages the active role of students to solve daily problems. The implementation of PBL leads to problems that are authentic in everyday life and meaningful to their learning journey. PBL supports students to understand the concepts and principles that bridge between these concepts so as to improve conceptual development and correct misconceptions. In addition, PBL can increase the high curiosity of students which leads them to find solutions to problems so that it has an impact on increasing achievement. The steps of the PBL model include problem-oriented, organizing students, planning research, conducting investigations, developing and presenting experimental results, as well as reflecting and evaluating the problem-solving process. The PBL model has many advantages, namely focusing on problems in order to encourage problem-solving abilities, building knowledge and assessing their own learning progress, and building students' scientific communication. Therefore, it is hoped that it can improve students' scientific literacy skill.

The choice of learning models is adjusted or tailored to the learning objectives to be achieved by students. Problem-based Learning (PBL) and Guided Inquiry (GI) are two examples of scientific approach-based learning models usually used in biology. These learning models allow students to gain experience in problem formulating, data collecting, data analysis, discussing the results, making conclusions, and predicting outcomes. (Firman et al., 2018).

In PBL activity, a real problem is faced at the beginning of learning activity then the students solved the problem through the teachers' guidance. However, the teachers do not dominate the learning activity to improve students' critical thinking skills and make the best decision (Dring, 2019). During PBL implementation, students are involved collaboratively in their groups to carry out problem-solving activities (Andersen et al., 2019). In these activities, students are formulating the problem, planning the problem-solving process, implementing the problem-solving plan, and reflecting their learning. On the other hand, in GI, students will learn science concepts through the scientific process, from formulating problems to presenting findings. GI offers an integrated unit of inquiry, planned and guided by an instructional team of a school librarian and teachers, allowing students to gain deeper understanding of the subject area of curriculum content and information literacy concepts (Servant-Miklos, 2019).

While most studies focus on the difficulties in Biology, the attributes of the students in Earth Science have not yet been studied. Thus, this research examined the contribution of Problem-based learning and Guided inquiry to students' critical thinking skills in Earth and Life Science.

Statement of the Problem

This study determined the effect of using scientific approach-based models on Earth and Life Science in enhancing the critical thinking skills of Grade 11 students in Salapungan National High School, San Rafael Bulacan during the School Year 2023 – 2024.

Specifically, it sought answers to the following questions:

1. How may the Grade 11 students' critical thinking skills in Earth and Life Science be described before exposing them to:
   - 1.1 traditional approach;
   - 1.2 problem-based learning; and
   - 1.3 guided inquiry?
2. How may the Grade 11 students' critical thinking skills in Earth and Life Science be described after exposing them to:
   - 2.1 traditional approach;
   - 2.2 problem-based learning; and
   - 2.3 guided inquiry?
3. Is there a significant difference between the Grade 11 students' critical thinking skills before and after exposing them to traditional approach, problem-based learning and guided inquiry?
4. What is the impact of using a scientific approach-based model in teaching Earth and Life Science on enhancing the critical thinking skills of students?

5. What are the views and insights of the Grade 11 students with regards to the utilization of problem-based learning and guided inquiry in teaching Earth and Life Science?
6. What program of activities can be crafted from the results of the study using the scientific approach-based method?

Hypothesis

There is no significant difference between the Grade 11 students' critical thinking skills before and after exposing them to traditional approach, problem-based learning and guided inquiry.

Conceptual Framework

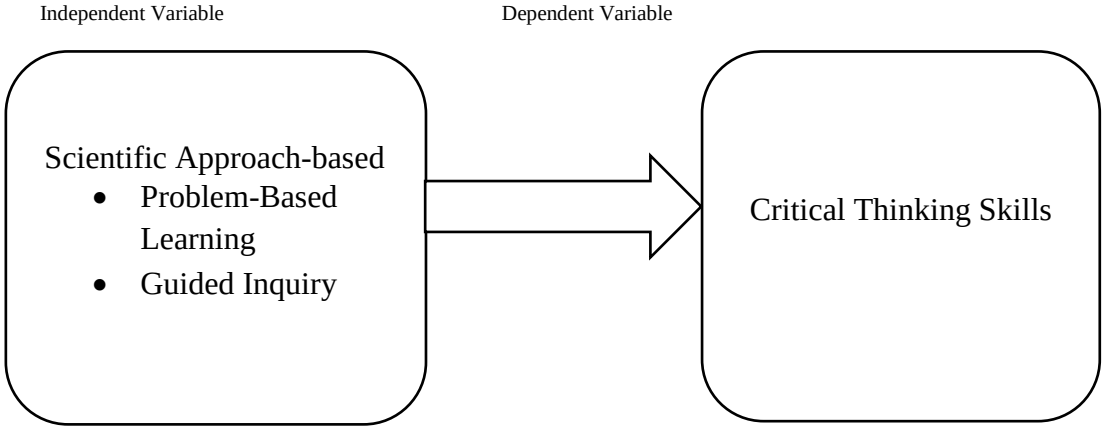

Figure 1. Paradigm of the Study

Figure 1 shows that the independent variables are the teaching strategies such as Problem-Based Learning and Guided Inquiry. These variables were hypothesized to affect (as implied by the arrowhead) the dependent variable which is the students' critical thinking skills in Earth and Life Science.

METHODOLOGY

The information about the research and sampling procedures that were utilized by the researcher are provided in this chapter. The research design that was employed, as well as the data gathering techniques, and data analysis scheme are also discussed in this chapter.

Research Design

The main objective of the study was to determine the use of scientific approach-based models in teaching Earth and Life Science to Grade 11 students. Furthermore, it looked into the respondents' views and insights as regards their experiences and the problems they encountered when they were subjected to the aforementioned strategies. In order to achieve this, the researcher utilized the explanatory sequential mixed methods design.

Creswell and Plano Clark (2018) define this design as first gathering quantitative data and then gathering qualitative data to help explain or elaborate on the quantitative results. The rationale behind this approach is that quantitative data and results provide a broad picture of the research problem; additional analysis, specifically qualitative data collection, is required to refine, extend, or explain the broad picture.

The researcher first collected and analyzed the quantitative data which was coming from the experiment. After conducting the experiment, qualitative data were collected through semi-structured interviews. Results from this phase were utilized to validate and further explain the quantitative findings of the study.

Data Gathering Technique

Prior to the conduct of the study, the researcher sent a request letter to the School's Division Superintendent of Bulacan to use the Grade 11 students as respondents of this research. Upon receiving the approved permit, the researcher coordinated with the principal of Salapungan National High School, San Rafael Bulacan. for the schedule of the experiment.

Before sending the letter of request, all the required documents by the Division Office and the Institute of Education of BASC were properly accomplished. The researcher saw to it that no classes were disrupted during the quantitative and qualitative data collection. Moreover, all respondents were informed that the gathered data were used solely for the research purposes only. After, passing the final defense which is expected to happen sometime in March 2024, all data saved in the researcher's laptop were permanently deleted.

Quantitative and qualitative data were gathered in the study. To gather the quantitative data, the researcher first conducted an orientation which was followed immediately by administering the pretest to the three groups of respondents who were exposed to Problem-Based Learning, Guided Inquiry and the traditional approach in teaching Earth and Life Science. After the pretest, the experiment proper was done wherein Table 1 or the Timetable of the

Study was strictly followed. It can be seen from the table that the experiment was done in 6 weeks wherein same topics were discussed to the three groups of respondents but the strategies that were applied were the Problem-Based Learning, Guided Inquiry and the traditional approach. After presenting all the lessons, posttests were administered.

For the collection of qualitative data, semi-structured interviews will be conducted. The researcher will utilize an open-ended questionnaire that will be formulated based on the findings that will be obtained in the quantitative data analysis. Results from this phase will be used to validate, support and arrive at a more comprehensive discussion of the results of the study.

Sampling Procedures

Total enumeration was used in the conduct of this study. All the three sections currently handled by the researcher was used as respondents of this research. Grade 11 ABM with 22 students were exposed to Problem-Based Learning, Grade 11 GAS with 47 students were exposed to Guided Inquiry and Grade 11 TVL with 39 students were subjected to traditional approach in teaching Earth and Life Science.

Table 1. Distribution of Respondents of the Study

Grade 11	Number of Students	Strategy
ABM	22	Problem-Based Learning
GAS	47	Guided Inquiry
TVL	39	Traditional approach

For the qualitative part, five (5) male and five (5) female students from Grade 11 GAS and ABM were selected at random to participate in the interview. They were subjected from the semi-structured interview to solicit their views and insights about their experiences and the problems that they encountered during the experiment.

Data Analysis Scheme

To describe the students' performance in pretests and posttests for the problem- based learning, guided inquiry and the traditional groups, mean and standard deviation were computed.

To determine if significant difference existed between the mean scores in the pretest and posttest for Problem-Based Learning, Guided Inquiry and the traditional groups, t-test analysis will be done.

To interpret the qualitative data collected from the interview, thematic analysis was utilized.

RESULTS AND DISCUSSIONS

This chapter deals with the presentation, analysis and interpretation of the data collected and the results of the statistical treatment employed in the study with the purpose of determining the effect of using scientific approach-based models on Earth and Life Science in enhancing the critical thinking skills of Grade 11 students.

The Grade 11 Students' Critical Thinking Skills in Earth and Life Science before Exposing them to Traditional Approach, Problem-Based Learning and Guided Inquiry

Critical thinking is essential in science. It is what naturally takes students in the direction of scientific reasoning since evidence is a key component of this style of thought.

It is not just about whether evidence is available to support a particular answer but how valid that evidence is. It is about whether the information the student has fits together to create a strong argument and how to use verifiable facts to get a proper response.

Table 2. The Students' Performance in Pretests

Score	Traditional Approach		Problem-Based Learning		Guided Inquiry	
	f	%	f	%	f	%
41 – 50	0	0.00	0	0.00	0	0.00
31 – 40	0	0.00	0	0.00	0	0.00
21 – 30	4	10.26	3	13.64	7	14.89
11 – 20	32	82.05	19	86.36	37	78.72

0 – 10	3	7.69	0	0.00	3	6.38
Mean	15.23		15.82		16.23	
SD	3.72		4.14		4.09	

Legend: 0-10 – Low 11-20 – Below Average 21-30 – Average 31-40 – Above Average 41-50 – High

It can be noted from the table that before exposing the Grade 11 students to traditional approach in teaching Earth and Life Science, 50-item pretest results show that majority or 82.05 percent of these students obtained scores from 11 to 20. On the other hand, 7.69 percent registered scores from 0 to 10. The mean was recorded at 15.23 (below average) and the standard deviation was calculated at 3.72. This indicates that the scores of the students are closer to the mean.

Examination of the same table reveals that in the 50-item pretest which was administered before exposing the Grade 11 students to problem-based learning, majority or 86.36 percent of them received scores that lie within the bracket of 11 to 20. Meanwhile, the remaining 13.64 percent of these respondents got scores from 21 to 30. A closer look at the table discloses that the mean and standard deviation were computed at 15.82 (below average) and 4.14 respectively. Results suggested that the baseline knowledge of the Grade 11 students before subjecting them to problem-based learning is below average.

Further perusal of Table 2 shows that in the 50-item test which was administered before exposing the Grade 11 students to guided inquiry, majority or 78.72 percent of the respondents registered scores from 11 to 20. On the other hand, 3.68 percent of these respondents obtained scores that lie within the lowest score bracket of 0 to 10. The mean was recorded at 16.23 (below average) while the standard deviation was registered at 4.09.

It can be noticed from the table that the computed mean scores for the pretests before exposing the respondents to Traditional Approach, Problem-Based Learning, Guided Inquiry are almost the same. These results suggest that before conducting the experiment, the students in the three groups are of the same baseline knowledge in so far as Earth and Life Science topics are concerned.

As to the computed standard deviation, results showed that the scores of the students in the traditional approach group are homogenous in nature. However, the computed standard deviations in the pretests for the Problem-Based Learning and Guided Inquiry groups implied that the homogeneity of the scores of the students in these groups are almost equal.

The Grade 11 Students' Critical Thinking Skills in Earth and Life Science after Exposing them to Traditional Approach, Problem-Based Learning and Guided Inquiry

Posttest is a test given to students after completion of an instructional program or segment and often used in conjunction with a pretest to measure their achievement and the effectiveness of the program.

In the study, after exposing the three groups of respondents to Traditional Approach, Problem-Based Learning, Guided Inquiry approaches in teaching Earth and Life Science, posttests were administered and results are manifested in Table 3.

Table 3. The Students' Performance in Posttests

Score	Traditional Approach		Problem-Based Learning		Guided Inquiry	
	f	%	f	%	f	%
41 – 50	0	0.00	5	22.73	3	6.38
31 – 40	4	10.26	15	68.18	23	48.94
21 – 30	30	76.92	2	9.09	21	44.68
11 – 20	5	12.82	0	0.00	0	0.00
0 – 10	0	0.00	0	0.00	0	0.00
Mean	24.97		36.91		32.36	
SD	4.51		5.10		6.31	

Legend: 0-10 – Low 11-20 – Below Average 21-30 – Average 31-40 – Above Average 41-50 – High

It can be observed from the table that in the 50-item posttest which was administered after exposing the Grade 11 students to traditional approach in teaching Earth and Life Science, more than three-fourths or 76.92 percent of them obtained scores from 21 to 30. On the other hand, only10.26 percent got scores from 31 to 40. Further observation of the table reveals that the mean was recorded at 24.97 (average) with a standard deviation of 4.51. This indicates that in applying the traditional approach of teaching Earth and Life Science, most students were not able to fully understand the topics presented by the teacher.

In the 50-item posttest which was administered after exposing the Grade 11 students to Problem-Based Learning approach in teaching Earth and Life Science, findings showed that majority or 68.18 percent of them obtained scores from 31 to 40. Meanwhile, more than one-fifth or 22.73 percent of the respondents received scores that lie within the highest bracket of 41 to 50. The mean and standard deviation were registered at 36.91 (above average) and 5.10, respectively. This discloses that a considerable portion of the students learned the topics when the teacher utilized the aforementioned approach.

Further observation of Table 3 shows that in the 50-item posttest which was administered after exposing the Grade 11 students to Guided Inquiry approach in teaching Earth and Life Science, results revealed that almost one-half or 48.94 percent of them obtained scores from 31 to 40. Meanwhile, 6.38 percent of the respondents received scores that lie within the highest bracket of 41 to 50. The mean and standard deviation were registered at 32.36 (above average) and 6.31, respectively. This means that only few students were able to absorbed the topics in Earth and Life Science when the teacher used Problem-Based Learning approach.

Results of the analyses indicate that the Grade 11 students learned more when the teacher applied Problem-Based Learning approach in teaching Earth and Life Science.

Similar to the present findings, the results of the research conducted by Kasuga et al., (2022) also showed that the use of the PBL approach increased the mean scores from pre-test to post-test. Also, the use of PBL showed an increase in students' scores on the achievement test compared to the traditional teaching methods. Traditional teaching methods have the ability to retain achievement at a low level of cognitive ability as compared to PBL. Furthermore, PBL showed that there was no significant difference in achievement statistically based on gender as compared to the traditional teaching methods. The study recommends a continuous use of learner-centered approaches such as PBL in teaching and learning science subjects including Biology.

In the conducted interview, the students were asked about their views and insights as regards the utilization of problem-based learning approach in teaching Earth and Life Science. Majority of the respondents replied that in this type of approach, they were challenged to work cooperatively in groups to seek solutions to real-world problems and to develop their skills to become self-directed learners. Further, they added that in this PBL approach, their critical thinking skills, problem-solving abilities, and communication skills were developed.

Meanwhile, when the students who were subjected to guided inquiry approach were asked to describe their experiences when their teacher used this approach in teaching Earth and Life Science, majority of these students replied that they enjoyed it when their teacher allowed them to take control of their own learning. Further, they stated that they found it fulfilling when they were the ones who discover the scientific concepts and theories with their teachers who guided them throughout the lessons.

The Difference between the Grade 11 Students' Critical Thinking Skills

In this part of the study, Table 4 presents the results of the t-test analyses which were performed to determine if significant difference existed between the students' performance in the pretests and posttests when they were exposed to Traditional Approach, Problem-Based Learning, Guided Inquiry approaches in teaching Earth and Life Science.

Table 4. Results of the t-test Analysis on the Difference between the Grade 11 Students' Critical Thinking Skills

Item	Mean		Mean	t-value	p-value
	Before	After	Diff.		
traditional approach	15.23	24.97	-9.74	10.412**	0.000
problem-based learning	15.82	36.01	-21.09	15.069**	0.000
Guided inquiry	16.23	32.36	-16.13	14.709**	0.000

Legend: ** = Highly Significant ($p \leq 0.01$)

As manifested in the table, highly significant difference was found between the students' pretest and posttest mean scores when they were subjected to traditional approach in teaching Earth and Life Science. This highly significant difference was brought about by the fact that the computed probability value of 0.000 is less than the 0.01 level of significance. This indicates that the traditional approach is effective in teaching Earth and Life Science among Grade 11 students. Further, this imply that the student learned the lessons in the aforementioned subject when the teacher used the traditional approach in teaching.

A closer look at the table reveals that highly significant difference was found between the students' pretest and posttest mean scores when they were subjected to problem-based learning approach in teaching Earth and Life Science. This highly significant difference is manifested by the computed probability value of 0.000 which is smaller than the 0.01 significance level. This finding discloses that problem-based learning approach is effective in teaching Earth and Life Science, that the students understand the lessons when this approach was used.

Further perusal of Table 4 shows that highly significant difference was found between the students' pretest and posttest mean scores when the teacher utilized guided inquiry approach in teaching Earth and Life Science among Grade 11 students. This highly significant difference is indicated by the computed probability value of 0.000 which is lower than the 0.01 significance level. This result implies that guided inquiry approach is effective in

teaching Earth and Life Science. Moreover, this means that the students were able to understand the topics presented by the teacher when the abovementioned approach was utilized.

In accordance to the present findings, Gomoll et al., (2020) opined that studies that have compared PBL with traditional approaches to teaching offer factual insights into the relative value of the PBL approach as a means of reaching student mastery of curricular content. These comparative studies revealed that PBL is an effective means of teaching content knowledge. For instance, the use of PBL had a positive impact on learning the mixtures topic in a Chemistry classroom as compared to the traditional approaches (Zhao et al., 2020). According to Hidayat et al., (2020), the use of PBL is more helpful in removing students' misconceptions of the intermolecular concepts in teaching and learning chemistry than the traditional teaching approaches. Studies that compared inquiry-based learning approaches such as PBL and guided inquiry methods on students' achievement revealed that inquiry-based learning approaches were better than traditional teaching methods in teaching Science. The study by Tawfik et al. (2020) showed that the use of PBL and guided inquiry as the best inquiry-based learning approaches outperformed the traditional teaching methods and case-based learning in Science conceptual understanding.

Table 4 presents the results of the analysis of variance which was performed in order to determine which among the three teaching approaches is the most effective in teaching Earth and Life Science to develop their critical thinking skills.

Table 5. ANOVA Table for the Differences among the Posttests Results

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2255.792	2	1127.896		
Within Groups	3147.644	105	29.978	37.625**	0.000
Total	5403.435	107			

Legend: ** = Highly Significant ($p \leq 0.01$)

It can be noted from the table that highly significant differences existed among the posttests mean scores of the students when they were exposed to Traditional Approach, Problem-Based Learning, Guided Inquiry approaches in teaching Earth and Life Science to develop critical thinking skills. This highly significant differences were brought about by the fact that the computed probability value of 0.000 is less than the 0.01 level of significance. This indicates that the performances of the students when they were subjected from the three aforementioned approaches are different from one another. Results also revealed that students performed best in PBL approach and least in the traditional approach of teaching.

In conjunction to the findings of the present study, the results of the study conducted by Funa and Prudente (2021) have also shown that PBL, as an approach to teaching science, had a large and positive effect on the achievement of secondary students. However, grade levels and various scientific disciplines did not influence students' learning achievement. The conduct of more studies on the different factors affecting PBL implementation and specific effects of PBL on various student domains is recommended to facilitate comparative educational research in the future.

In the conducted interview with the Grade 11 students who were exposed to PBL, they were asked if there is a need to use PBL in other subjects. All these respondents replied that they firmly believed that PBL must be utilized in all subjects for them to develop their critical thinking skills.

The respondents who were subjected to PBL and guided inquiry approaches of teaching were also asked about the problems that they encountered during the experiment. All of them replied that the most common problem that they encountered was some of their classmates did not cooperate during the activities. Further, they added that some of their classmates do not have the focus on what they do.

Program of Activities Crafted from the Results of the Study

Results of the study revealed that PBL is the most effective approach in developing the critical thinking skills of the students in teaching Earth and Life Science. Hence, the researcher proposed a plan to share the results of the present study to her colleagues so that they can also apply this in their own classes.

Table 6. Proposed Activities for Problem-based Learning

Objectives	**Action**	**Timeline**	**Persons Involved**	**Expected Outcome**
To make other teachers aware of the importance of using PBL in developing the critical thinking skills of the students.	Conduct a meeting with other teachers and discuss the findings of the study.	1st Quarter of S.Y. 2024-2025	Researcher, Principal Teachers	At the end of the meeting, teachers are expected to use PBL in their own classes.
To gain more knowledge on how to apply PBL in each subject.	Invite speaker who is expert in PBL utilization.		Researcher, Invited speaker. Teachers	Teachers are expected to be equipped with adequate knowledge on PBL utilization.

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary of the major findings, the conclusions arrived at based on the findings, and the recommendations given in accordance with the conclusions.

Findings

This study determined the effect of using scientific approach-based models on Earth and Life Science in enhancing the critical thinking skills of Grade 11 students in Salapungan National High School, San Rafael Bulacan during the School Year 2023 – 2024.

Using the procedures described in the preceding chapter, the answers to the problems raised in this study were ascertained and summarized as follows: Findings revealed that the Grade 11 students' critical thinking skills in Earth and Life Science before exposing them to traditional approach, problem-based learning and guided inquiry was described as "below average."

After conducting the experiment, the Grade 11 students' critical thinking skills in Earth and Life Science after exposing them to traditional approach was described as "average." On the other hand, the Grade 11 students' critical thinking skills in Earth and Life Science after exposing them to problem-based learning and guided inquiry was described as "above average."

Highly significant difference was found between the students' pretest and posttest mean scores when they were subjected to traditional approach in teaching Earth and Life Science.

Similarly, highly significant difference was found between the students' pretest and posttest mean scores when they were subjected to problem-based learning approach in teaching Earth and Life Science.

Likewise, highly significant difference was found between the students' pretest and posttest mean scores when the teacher utilized guided inquiry approach in teaching Earth and Life Science among Grade 11 students.

In the same vein, highly significant differences existed among the posttests mean scores of the students when they were exposed to Traditional Approach, Problem-Based Learning, Guided Inquiry approaches in teaching Earth and Life Science to develop critical thinking skills.

Conclusions

Based on the findings of the study, the following conclusions were drawn: Traditional, Problem-Based Learning, Guided Inquiry approaches are effective in teaching Earth and Life Science to develop critical thinking skills.

PBL approach is the most effective and the least effective is the traditional approach in teaching Earth and Life Science to develop critical thinking skills among Grade 11 students.

Recommendations

In light of the findings and conclusions of the study, the following recommendations are hereby offered:

1. Science teachers may continue to test other approaches in teaching to further develop the critical thinking skills of the students.
2. The program of activities may implement to enhance Science teaching.
3. For future researchers, further research along this line could be conducted. The same study may be conducted by including the attitude of the students as variable of the study.

REFERENCES

Andersen, A. L., Brunoe, T. D., & Nielsen, K. (2019). Engineering education in changeable and reconfigurable manufacturing: Using problem-based learning in a learning factory environment. *In Procedia CIRP* (Vol. 81, pp. 7–12). Elsevier. doi: https://doi.org/10.1016/j.procir.2019.03.002

Arifullah, A. Halim, M. Syukri, and E. Nurfadilla, (2020). The Effect of guided inquiry to students' academic performance. *J. Phys. Conf. Ser*. 1460(1), p. 012144.

Artayasa, IP. (2018). The Effect of Three Levels of Inquiry on the Improvement of Science Concept Understanding of Elementary School Teacher Candidates. *International Journal of Instruction*. 11 (2): 235-248.

Balagtas, M., Garcia, D. & Ngo, D. (2019). Looking through Philippine's K to 12 curriculum in mathematics and science vis-à-vis TIMSS 2015 assessment framework. *EURASIA Journal of Mathematics, Science and Technology Education*, 15/12.

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and Conducting Mixed Methods Research* (3rd ed.). Sage Publications.

Digal, NBT and Walag, AMP. (2019). Self-Efficacy, Study Habits and Teaching Strategies and It's Influence on Student Science Performance: A Cross-Sectional Study, *Asia Pacific J. Soc. Behav. Sci*., vol. 16, pp. 51-76.

Dring, J. C. (2019). Problem-based learning – Experiencing and understanding the prominence during medical school: Perspective. *Annals of Medicine and Surgery*, 47, 27–28. doi: https://doi.org/10.1016/j.amsu.2019.09.004

Duque, DAG and Roleda, LS. (2019). The Effect of Influence-Embedded Physics Instruction on Student Academic Performance. *Physics Education*, 8(4), 32-44.

Ertmer, P., & Koehler, A. A. (2018). Facilitation strategies and problem space coverage: comparing face-to-face and online case-based discussions. *Educational Technology Research and Development*, 66(3), 639–670.

Firman, F., Baedhowi, B., & Murtini, W. (2018). The effectiveness of the scientific approach to improve student learning outcomes. *International Journal of Active Learning*, 3(2), 86–91. Retrieved from https://journal.unnes.ac.id/nju/index.php/ijal/article/view/13003

Funa, A. A., & Prudente, M. S. (2021). Effectiveness of problem-based learning on secondary students' achievement in science: A meta-analysis. *International Journal of Instruction*, 14(4), 69-84. https://doi.org/10.29333/iji.2021.1445a

Gomoll, A., Hillenberg, B., & Hmelo-Silver, C. E. (2020). I have never had a PBL like this before' On viewing, re-viewing, and co-design. *Interdisciplinary Journal of Problem-Based Learning*, 14(1). https://doi.org/10.14434/ijpbl.v14i1.28802.

Goodin, T. L., Caukin, N. G., & Dillard, H. K. (2019). Developing clinical reasoning skills in teacher candidates using a problem-based learning approach. *Interdisciplinary Journal of Problem-Based Learning*, 13(1), 1–17.

Iriani, A. Herlina, Y. Irhasyuarna, R. E. Sanjaya, (2019). Modul Pembelajaran Problem-Based Learning Berbasis Lahan Basah untuk Mempersiapkan Calon Pendidik Berwawasan Lingkungan Lahan Basah, *Jurnal Inovasi Pendidikan IPA* 5(1) 54–68. DOI: https://doi.org/10.21831/jipi.v5i1.23337

Jongman, M. (2017). *The Impact of Social Interdependence Theory in Supply Chain Management*. http://essay.utwente.nl/72736/1/Jongman_BA_BMS%5B1%5D.pdf.

Kasuga, W., Maro, W. & Pangani, I. (2022). Effect of problem-based learning on developing science process skills and learning achievement on the topic of safety in our environment. *Journal of Turkish Science Education*, 19(3), 872-886.

Li, H. C., & Stylianides, A. J. (2018). An examination of the roles of the teacher and students during a problem-based learning intervention: Lessons learned from a study in a Taiwanese primary mathematics classroom. *Interactive Learning Environments*, 26(1), 106–117.

Mamede, S., Figueiredo-Soares, T., Elói Santos, S. M., de Faria, R. M. D., Schmidt, H. G., & van Gog, T. (2019). Fostering novice students' diagnostic ability: The value of guiding deliberate reflection. *Medical Education*, 53(6), 628–637.

Moallem, M., Hung, W., & Dabbagh, N. (Eds.). (2019). *The Wiley Handbook of Problem-Based Learning* (1st ed., Vol. 20, pp. 273–295). Wiley

Razali, A. Halim, A. G. Haji and E. Nurfadilla, (2020). Guided Inquiry in teaching Science. *J. Phys. Conf. Ser.* 1460(1), p. 012118.

Rillero, P., & Camposeco, L. (2018). The iterative development and use of an online problem-based learning module for preservice and inservice Teachers. *Interdisciplinary Journal of Problem-Based Learning*, 12(1), 7.

Saldo, IJP and Walag, AMP. (2020). Utilizing Problem-Based and Project-Based Learning in Developing Students' Communication and Collaboration Skills in Physics. *American Journal of Educational Research*, vol. 8, no. 5 (2020): 232-237. doi: 10.12691/education-8-5-1.

Servant-Miklos, V. F. C. (2019). Fifty years on: A retrospective on the world's first problem-based learning Programme at McMaster University Medical School. *Health Professions Education*, 5(1), 3–12. doi: https://doi.org/10.1016/j.hpe.2018.04.002

Tawfik, A. A. Hung, W., & Giabbanelli, P. J. (2020). Comparing how different inquiry-based approaches impact learning outcomes. *The Interdisciplinary Journal of Problem-based Learning*, 14(1), 1-17. https://doi.org/10.14434/ijpbl.v14i1.28624

Valdez, J., and Bungihan, M. (2019). Problem-based learning approach enhances the problem solving skills in chemistry of high school students. *Journal of Technology and Science Education*, 9(3), 282-294. https://doi.org/10.3926/jotse.631

Wahyu, Rofikhatul Rikha Ula and Mariyani, Anna (2021) The Development of Guided Inquiry Based Science Basic Concept Teaching Materials. *J. Phys.: Conf. Ser*. 1842, 012079

Zamista, A.A. (2019). Development of Physics Module based on Process Oriented Guided Inquiry Learning as a Tool to Increase Student Science Process Skills. *International Seminar on Science Education*. 1233.

Zhao, W., He, L., Deng, W., Zhu, J., Su, A., & Zhang, Y. (2020). The effectiveness of the combined problem-based learning (PBL) and case-based learning (CBL) teaching method in the clinical practical teaching of thyroid disease. *BMC Medical Education*, 20(381), 1-10.