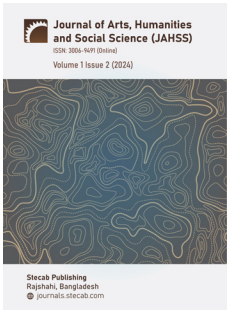

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Research Article

Problem-based Learning (PBL) Using Resource Mining as a Teaching Approach: An Action Research

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About Article

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ABSTRACT

Problem-Based Learning (PBL) is a teaching approach wherein learners are immersed in different issues to create real-life solutions. This approach is widely used to increase learners' academic performance and promote positive behavioral change. Following the positive impacts of this approach, this study was conducted to uncover the possibility of merging PBL with secondary resources (articles, videos, recorded lectures) to create an innovative teaching approach responsive to the call for ICT integration in 21st-century education in teaching scientific concepts. A quasi-experimental research design was used in this study with a total of 240 Grade 7 participants (six sections). The selection of this target group is based on the PISA 2022 result wherein the Philippines have attained a very low performance in the scientific literacy component. Following this, a pretest was administered to each volunteered participant, and groupings were assigned based on the mean score of their result (control and experimental). Analysis shows no statistically significant difference in the targeted group's pre-test performance, confirming that all groups have the same knowledge on the topic (atmospheric phenomena). The developed approach was implemented in the experimental group, and the control group was immersed in the traditional way of teaching. Data shows that the overall post-test performance of the experimental group is fairly satisfactory (%=79.73), while the control group's performance did not meet the expectation (%=60.13). Analysis further revealed a statistically significant difference between the experimental and control groups. Moreover, when analyzed by Hake's gain method, the experimental group achieved a medium gain performance while the control have achieved a low gain performance. The findings of this study imply that merging PBL with secondary resources can increase learners' performance on atmospheric phenomena topics. Thus, this study suggests to use PBL with secondary resources in teaching environmental-related concepts to increase learners' knowledge and awareness.

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1. INTRODUCTION

Education has become relevant in 21st-century education due to various issues society faces. The history of education is replete with appeals to enhance the active engagement of students in the learning process (Merritt *et al.*, 2017). By enabling informed decision-making and effective problem-solving, scientific literacy is crucial in addressing today's complex challenges, such as climate change, food scarcity, public health crises, and online misinformation (Calleja, 2023). However, in 2022, the Programme for International Student Assessment (PISA) assessed the knowledge and skills of 15-year-old students in mathematics, reading, and science. The results revealed that the students from the Philippines ranked third to the last among 81 countries in scientific literacy (OECD, 2023). Following this gap, this study uses a modified strategy through problem-based learning and to check if this strategy can be used to increase learners' scientific literacy.

Problem-based learning (PBL) is an instructional method where students collaborate to solve problems, engage in self-directed learning (SDL), and reflect on their strategies. The teacher facilitates rather than directly imparts knowledge (Diquito *et al.*, 2022; Hmelo-Silver, 2004). Psychological research indicates that solving problems enables students to acquire content knowledge and thinking strategies. In high school, the science subject lays the groundwork for critical thinking, analytical skills, and scientific literacy (Caballes *et al.*, 2024). Thus, by immersing learners in a real-life situation, learners become more knowledgeable and problem-solvers(Harackiewicz *et al.*, 2016; Yew & Goh, 2016). Therefore, investing in real-life applications and decision-making classroom activities and strategies promotes higher learning among learners.

The United Nations General Assembly adopted Agenda 2030 in 2015, establishing 17 Sustainable Development Goals (SDGs) to guarantee a sustainable, peaceful, prosperous, and just life for all. As this declaration outlines, pursuing sustainable development requires a profound transformation in how we think and act. To contribute to the proposed goals, people must possess scientific competencies beyond mere science knowledge, including skills, values, and attitudes toward science. This overall approach, Education for Sustainable Development (ESD), is crucial to achieving the SDGs (Charro *et al.*, 2021; Villamor *et al.*, 2023). Moreover, it is very important to advance scientific literacy by implementing policies anchored to the community's current needs.

However, initiatives to advance science literacy and education have faced significant obstacles. For example, the No Child Left Behind Act of 2001 in the United States prioritized high-stakes testing, diminishing the autonomy of teachers and schools and impeding essential reforms in science education practices (Pompea & Russo, 2021). In Cambodia, the popularity of science subjects among high school students has gradually declined (Thy *et al.*, 2023). According to the 2018 National Assessment, Cambodian students have continued to perform poorly in science. This trend is concerning, as pursuing the path of sustainable development, as outlined in the United Nations' Agenda 2030, requires a profound transformation in how we think and act, and individuals must possess scientific competencies to contribute to the proposed goals.

In the Philippines, the K to 12 Curriculum Guide for Science (2013) aims to cultivate scientifically literate citizens who are informed, active members of society, responsible decision-makers, and capable of applying scientific knowledge to impact society and the environment positively. Specifically, the science curriculum is designed to enhance three key learning domains in students: performing scientific processes and skills, understanding and applying scientific knowledge, and developing scientific attitudes and values (Montebon, 2014). In a study conducted by Bernardo *et al.* (2008) entitled "Student's Perception in Science Classes in the Philippines," the findings reveal a decline in science inquiry activities and the reliance on grades for feedback in higher grades.

In the local context, this classroom-based action research took place at a local high school in Digos City, Philippines. This investigation sought to assess the efficacy of Problem-Based Learning (PBL) in augmenting students' mastery of atmospheric phenomena. Particularly beneficial for students encountering challenges in comprehending scientific concepts and their practical applications, the instructional intervention unfolded within the participants' classroom setting. Preceding the commencement of the experiment, students underwent a pre-test gauging their grasp of atmospheric phenomena concepts, including atmospheric layers, the greenhouse effect, monsoons, and the Inter-Tropical Convergence Zone (ITCZ). This pre-test served as a benchmark for comparing students' academic performance before and after exposure to the proposed intervention.

The study involved 240 Grade 7 learners from six sections during the academic year 2023-2024. Moreover, these participants are selected based on the age bracket stipulated by the PISA 2022 report. Following these, a total of six sections were subject to the study. A thirty-item pre-test was administered to assess the student's knowledge of atmospheric phenomena. The pre-test results indicated no significant difference among the selected sections. When analyzed, the mean score revealed a slight variation but yielded no significant difference. These findings suggest that learners have the same understanding of the aforementioned competencies regardless of their sections.

Following the gaps and rationale, the study aimed to evaluate the effectiveness of implementing modified Problem-Based Learning (PBL) in improving students' scientific literacy of atmospheric phenomena competencies. The findings hold significance for various stakeholders, such as educators, students, and curriculum planners, to utilize this strategy in delivering instruction related to the competencies being tested in this study. Moreover, to properly assess the effectiveness of this innovation, the following objectives are needed to address: (1) determine the overall performance of the participants in their pre-test and post-test, (2) determine if there is a significant difference between the pre-test and post-test scores of the participants before and after implementing the intervention, and (3) know the percentage of increase/decrease of participants performance using Hake's Gain analysis.

2. LITERATURE REVIEW

Research has consistently shown that Problem-Based Learning (PBL) is an effective instructional approach with various benefits

across different educational contexts. For instance, Capon and Kuhn (2004) demonstrated that PBL enhances students' ability to explain and integrate new information with existing knowledge structures, outperforming traditional lecture methods in long-term retention. In addition, Gallagher *et al.* (1992) highlighted that PBL promotes spontaneous use of problem-solving steps among high school students, revealing significant improvements not observed in traditional settings. Similarly, Sungur (2004) found that PBL significantly boosts academic achievement, intrinsic motivation, and critical thinking skills in high school biology students compared to traditional instructional methods. Complementing these findings, Goodnough and Cashion (2006) explored the implementation challenges and benefits of PBL in high school science, noting that students appreciated the active learning environment and its relevance to real-world issues. Lastly, Wilder (2014) conducted a systematic review of the impact of PBL on academic achievement, concluding that while PBL is not definitively superior in content knowledge acquisition, it excels in developing essential skills such as communication, collaboration, and critical thinking, which are often inadequately addressed by traditional teaching methods. Collectively, these studies underscore the multifaceted advantages of PBL, suggesting its potential as a transformative instructional approach in secondary education.

In our research, we utilized various data sources, including article reading, instructional videos, and online lectures, to explore our topic comprehensively. Aliponga (2013) investigated the benefits of reading journals in extensive reading courses, highlighting their ability to motivate students, improve understanding, and encourage critical thinking. Similarly, Blikstad-Balas and Sørvik (2015) employed video analysis to examine literacy practices in educational contexts, revealing the complex interplay of different literacy skills within classrooms. A study by Angrave *et al.* (2020) that analyzed behavioral data from online lecture videos using ClassTranscribe revealed that the students demonstrated positive academic outcomes associated with diverse viewing behaviors, including enhanced exam performance across different performance quartiles. Additionally, Mavlankar *et al.* (2010) introduced ClassX, an interactive lecture streaming system that enhances engagement through features such as pan, tilt, and zoom controls, enhancing the learning experience. Lastly, Costley *et al.* (2021) investigated the impact of specific video lecture viewing strategies on cognitive load management, revealing how strategic viewing practices can reduce unnecessary cognitive burdens and improve learning efficiency.

3. METHODOLOGY

3.1. Research Design

This study is an Action Research emphasizing a quasi-experimental research design. Action research as defined by Somekh (2005) as a methodology suited when the research involves innovation or change. Moreover, the quasi-experimental research design was used to uncover the participants' performance in both pretest and posttest. This study used the quasi-experimental design to determine if the proposed teaching approach can effectively increase learners' scientific literacy. As noted by Maciejewski (2020), quasi-experimental research design is primarily used to uncover distinctions among groups. Thus, this design is the most appropriate for this action research since the goal of this study involves innovation in science teaching.

3.2. Participants

The participants of this study were 240 Grade 7 students from one public school in Digos City, Philippines. This group of students comes from six sections. Moreover, this group of students was later categorized into two groups, namely the control and experimental groups. Random assignments of groups were utilized by the researchers since the mean scores of each section are close to one another, thus indicating that there is little to no difference in their pre-test results (Table 1).

Table 1. Groupings (per Section) and Participants Performance.

Section	Group	No. of Students	Pre-Test (Mean)	Pre-Test (SD)
1	Control	37	15.95	2.99
2	Control	42	14.66	3.55
3	Control	41	14.39	3.59
4	Experimental	39	15.60	4.42
5	Experimental	40	14.73	3.81
6	Experimental	41	14.26	3.60

3.3. Proposed Innovation (Strategy)

This study utilizes Problem-Based Learning (PBL) with article reading, video presentation, and lecture viewing to a specific competency under the topic of atmospheric phenomena for Grade 7 Science under the K-12 curriculum in the Philippines. The researchers call this approach as "Direct Learning Using Secondary Data Resources" to support competencies mandated by the Department of Education in the Philippine government. This approach aligns with the call for Information Communication Technology (ICT) integration in learning. ICT in the learning process is crucial in this generation since it allows learners to be prepared for the real world, where technology is used daily (Rohatgi *et al.*, 2016). Moreover, the researchers integrate the PBL into this approach to become realistic, allowing learners to identify problems and promote actions based on the identified problems. Thus, this study called this innovation "PBL-Resource Mining." Details of the developed innovation are outlined in Matrix 1.

3.4. Data Gathering Procedure

The following are the steps and procedures that were taken by the researchers:

3.4.1. Phase I: Preparation Stage

Step 1: Prior to the conduct of the study, the researchers first ask for permission from the school head and teachers to conduct this action research on the selected grade 7 students. The researchers also asked permission from the selected

Matrix 1: Plan of Activities with the Developed Innovation Strategy to Address the Target Competencies.

Competency	Strategy	Output
Competency 1: Layers of Atmosphere	Article Reading • Below are the used YouTube videos: 1) https://science.nasa.gov/earth/earth-atmosphere/earths-atmosphere (NASA, 2019) 2) https://www.nasa.gov/general/what-is-earths-atmosphere/ (Loiacono, 2024)	The output of this activity is a concept map that explains how to address these issues.
Competency 2: Greenhouse Effect and Global Warming	Video Presentation of News Regarding Greenhouse Gas • Below are the used YouTube videos: (1) https://www.youtube.com/watch?v=SN5-DnOHQmE (NASA Space Place, 2020) (2) https://www.youtube.com/watch?v=d4BFgtU0hJU (CBS News, 2022) (3) https://www.youtube.com/watch?v=dIsjcG7hTmo (BBC Earth, 2021) (4) https://www.youtube.com/watch?v=oJAbATJCugs(National Geographic, 2007) (5) https://www.youtube.com/watch?v=jBQS00kgG8g (Rau's IAS Study Circle (since 1953), 2024) (6) https://www.youtube.com/watch?v=FoGzSRBRQYE (INQUIRER.net, 2023)	The output of this activity is a group presentation that highlights environmental issues faced in the Philippines and solutions proposed by the learners.
Competency 3: Atmospheric Phenomena: Breezes, Monsoons, Itcz	Lecture Viewing • Below are the videos used: (1) https://youtu.be/dz6keC9Pn1Q?si=QQKmLFEzT-1QLrjw (SirBas TV, 2021) (2) https://www.youtube.com/watch?v=bBTIjwcVgEo (Z Wonderful World, 2021)	The output of this activity is a reflection paper developed by students on their current roles as a member of the community.

participants if they were willing to participate in the study. After the approval, the researchers conducted an orientation to the target participants regarding the nature and purpose of the study. After the orientation, the researchers then ask again the participants if they are still willing to participate in the study. From this, a total of 240 learners out of 287 agreed to participate in the study.

Step 2: The researchers developed a set of questions for the Pre- and Post-tests. The test consisted of thirty items that covered the three (3) competencies related to atmospheric phenomena. There were ten (10) questions in each competency. Furthermore, the first competency is about the Layers of the Atmosphere; the second Covered Global Warming and The Greenhouse Effect; the third competency is about the Common Atmospheric Phenomena. These questions were validated by three experts to determine its validity.

Step 3: The researchers used Problem-based learning as a pedagogical approach to teaching about the concept of atmospheric phenomena. Moreover, the researchers developed a plan that is outlined in Matrix 1 in this action research.

Step 4: After designing the plan, the researchers conducted a Pre-Test to determine learners' performance in the competencies highlighted in the study. Mean scores were calculated per section, and each group (experimental and control) was done randomly.

Step 5: The researchers categorized the participants into two. Those who belonged to the Experimental Group were the sections that the developed strategy was implemented. Meanwhile, those who belonged to the Control Group were the sections to experience the traditional teaching approach.

3.4.2. Phase II: Implementation Stage

Step 6: Guided by the Budget of Work (BOW) planned by the Grade 7 Science Teachers, seven days were allocated to cover the competencies focused in this study. In line with that, the implementation of the said intervention runs in nine days.

Step 7: The researchers organized the activities of the PBL approach to cover everything within nine days: 2 days for competency 1: Layers of the Atmosphere; 2 days for competency 2: the Greenhouse Effect and Global Warming, 3 days for competency 3: Brezzes, Monsoons, etc., and 2 days for the assessment.

3.4.3. Phase III: Post-Implementation Stage

Step 8: After implementing the PBL approach, the researchers conducted a post-test on all the participants to determine the effectiveness of the teaching strategy.

Step 9: After conducting the Post-test, the researchers interpreted and analyzed the students' test scores, comparing their Pre-Test results to the Post-test scores. The mean scores of the sections in the experimental group and the control group were also used to evaluate the effectiveness of Problem-Based Learning in comparison to the traditional approach of the teacher.

3.5. Data Analysis

The researchers used the following analysis in this study: percentage, independent sample t-test, and Hakes gain. Percentage were used to determine students' performance before and after implementing the developed strategy. The use of a percentage range in the study of Abrantes and Casinillo (2020) was used in the study (Table 2). Moreover, independent sample t-tests were used to determine if there was a significant difference in the participant's performance before and after the implementation of the strategy (Alejandria *et al.*, 2023).

Table 2. Interval of Academic Performance

Academic Performance	Description
90 and Above	Outstanding
85 - 89	Very Satisfactory
80 - 84	Satisfactory
75 - 79	Fairly Satisfactory
74 and below	Did Not Meet the Expectation

Moreover, the Hakes gain was used to determine how much the students learned before implementing the strategy (Hake, 1998). The formula for Hake's gain method is <g>=<post-test>-<pre-test> / N items - <pre-test>, where g refers to the average normalized gain, <pre-test> refers to the average pre-test scores of learners, <post-test> refers to the average post-test score, and N items refer to the number of items in the test. Table 3 shows the interpretation of Hakes gain used in the study.

Table 3. Hake's Gain Interpretation

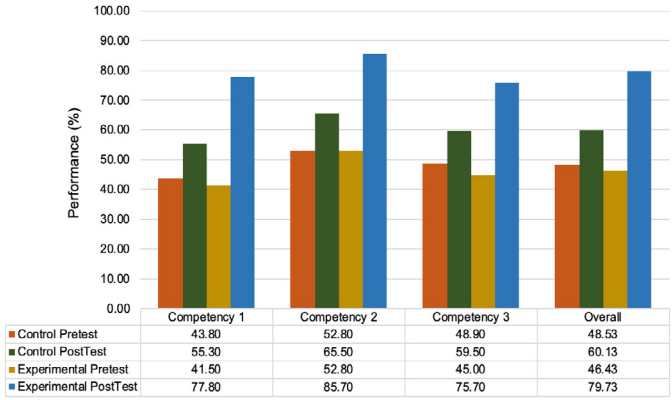
Hakes Gain value (g)	Interpretation
> 0.7	High Gain
between 0.3 to 0.7	Medium Gain
< 0.3	Low Gain

4. RESULTS AND DISCUSSION

4.1. Performance of Participants Before and After the Implementation of the Approach

Figure 1 shows the comparative performance of participants before and after the implementation of the teaching approach in different groups. Data shows that the overall post-test performance of participants in the experimental group on the topic of atmospheric phenomena can be interpreted as "fairly satisfactory" (%=79.73), whereas their overall pre-test performance can be interpreted as "did not meet the expectation" (%=46.43). While both the overall performance of the control group pre-test and post-test performance can be interpreted as "did not meet the expectation" (pre-test (%)=48.53; post-test (%)=60.13). The result indicates that the teaching approach positively increases students' performance on atmospheric phenomena, as evidenced by the performance of the experiment group.

Moreover, based on the three competencies being measured in the study, the experimental group attained "fairly satisfactory" for both Competency 1: Layers of Atmosphere (%=77.80) and Competency 3: Atmospheric Phenomena: Breezes, Monsoons, Itcz (%=75.70) while Competency 2: Greenhouse Effect and Global Warming (%=85.70) attained a "very satisfactory performance in their post-test. Their post-test performance is higher compared to their pre-test performance in all competencies, and the results of their pre-test can be interpreted as "did not meet the expectation" (Competency 1 (%=41.50); Competency 2 (%=52.80); Competency 3 (45.00)). While the control group performance in both pre-test and post-test in all competencies are interpreted as "did not meet the expectation" (Competency 1 (pre-test (%=43.80); post-test (%=55.30)); Competency 2 (pre-test (%=52.80) post-test (65.50)); Competency 3 (pre-test (%=48.90); post-test (%=59.50)).



	Competency 1	Competency 2	Competency 3	Overall
Control Pretest	43.80	52.80	48.90	48.53
Control PostTest	55.30	65.50	59.50	60.13
Experimental Pretest	41.50	52.80	45.00	46.43
Experimental PostTest	77.80	85.70	75.70	79.73

Figure 1. Comparative Performance of Participants Pretest and Posttest Result

The findings of the study are supported by Sari *et al.* (2021) that problem-based learning (PBL) has a positive effect on student's learning specifically in promoting problem-solving and scientific writing skills. In addition, Gorghiu *et al.* (2015) also acknowledged the importance of PBL in promoting scientific competencies as a form of life-long learning. Further, the use of article reading (Shanahan, 2020), videos (Chen *et al.*, 2020), and lecture viewing (Leo & Puzio, 2016) in science instruction can yield positive results in increasing student's learning. Thus, combining PBL and downloaded secondary data sources can yield a positive result in student performance, as evidenced in this study.

4.2. Significant Difference in Participant's Performance Before and After the Implementation of the Approach Across Groups

Table 4 shows the result in each competency and the overall result of the independent sample t-test. Data revealed that the overall result in the pre-test of control group ($\bar{x}$=14.56; SD=3.53) and experimental group ($\bar{x}$=13.93; SD=4.94); (t=1.128; p=0.261) has no statistically significant difference. This means that, regardless of groups, their overall performance on the topic of atmospheric phenomena is the same. In addition, when analyzed in terms of each competency, the result also revealed that there is no statistically significant difference among groups (competency 1 (t=1.12, p=0.261); Competency 2 (t=0.037, p=0.97); Competency 3 (t= 1.729, p=0.085)) in terms of their pre-test result. This means that their performance on the assessed competencies is the same regardless of group.

Moreover, after the implementation of the developed approach, data revealed that there is a statistically significant difference in the post-test performance between the control group ($\bar{x}$=18.04; SD=3.81) and experimental group ($\bar{x}$=23.92; SD=3.67); (t=-8.77; p=<.01). This means that the implemented approach can improve the performance of learners in the topic atmospheric phenomena as evidence in the mean score and statistically significant difference result. In addition, when analyzed in terms of each competency, the result also revealed that there is a statistically significant difference among groups (competency 1 (t=-11.442; p=0.01); competency 2 (t=-10.21; p=0.01); competency 3 (t=-8.77; p=0.01)).

Table 4. Result of Independent Sample T-test on the Performance of Participants Across Groups

		Group	Mean	SD	*t*	*p*
Competency 1	Pretest	Control	4.38	1.53	1.12	0.264
		Experimental	4.15	1.69		
	Post-Test	Control	5.53	1.63	-11.442	<0.01**
		Experimental	7.78	1.4		
Competency 2	Pretest	Control	5.28	1.32	0.037	0.97
		Experimental	5.28	2.07		
	Post-Test	Control	6.55	1.6	-10.21	<0.01**
		Experimental	8.57	1.46		
Competency 3	Pretest	Control	4.89	1.32	1.729	0.085
		Experimental	4.5	2.07		
	Post-Test	Control	5.95	1.6	-8.77	<0.01**
		Experimental	7.57	1.46		
Overall	Pretest	Control	14.56	3.53	1.128	0.261
		Experimental	13.93	4.94		
	Post-Test	Control	18.04	3.81	-8.77	<0.01**
		Experimental	23.92	3.67		

***p<.05 (The independent sample t-test is significant if the p-value is less than 0.05)*

The overall results of this study were also consistent with the various related studies. It was affirmed by Armalia *et al.* (2017) that PBL helps increase students' academic performance by enhancing the learners' higher-order thinking skills (HOTS). As stated by Dabbagh (2019) that problem-based learning helps develop student's skills, such as their creative and critical thinking skills, as they work independently. Further, it was revealed in a study that the critical thinking skills of students improved after applying the Problem-based learning approach to learning about lipid metabolism (Seruni *et al.*, 2020). Asyari *et al.* (2016) also recommended using PBL as it enhances the learners' critical thinking skills. Thus, the findings of this study confirmed the literature being discussed above. Therefore, PBL, with downloaded secondary resources, can be used to enhance learners' performance.

4.3. Differences in the Performance of Groups when Analyzed Using Hakes Gain Analysis

Table 5 shows Hake's gain value and interpretation of the overall performance and each competency performance per group. Data shows that the experimental group's overall performance and performance for each competency have achieved a "medium gain" result (overall=0.62; competency1=0.62; competency2=0.70; competency3=0.62). This means that the developed approach has a moderate effect in terms of increasing learners' performance on the topic of atmospheric phenomena. While the control group achieved a "low gain" performance in both overall and each competency being tested (overall=0.23; competency1=0.20; competency2=0.27; competency3=0.21). The findings shows that the traditional way of teaching (lecture) can yield a low gain performance among learners.

Table 5. Hakes Gain Value and Interpretation on the Performance of each Groups

Group	Competencies	Pre-Test Score	Post-Test Score	Hake's Gain Value	Interpretation
Control Group	Competency 1	4.38	5.53	0.20	Low Gain
	Competency 2	5.28	6.55	0.27	Low Gain
	Competency 3	4.89	5.95	0.21	Low Gain
	Overall	14.56	18.04	0.23	Low Gain
Experimental Group	Competency 1	4.15	7.78	0.62	Medium Gain
	Competency 2	5.28	8.57	0.70	Medium Gain
	Competency 3	4.50	7.57	0.56	Medium Gain
	Overall	13.93	23.92	0.62	Medium Gain

The result of Hake's gain analysis shows that introducing PBL with downloaded secondary data resources can have a medium positive effect on learners' performance compared to the traditional way of teaching (lecture). This result is consistent with various literature that PBL can moderately affect learners' academic achievement (Dochy *et al.*, 2003; Dolmans *et al.*, 2016; Hmelo-Silver, 2004b). Though the result of Hake's gain analysis shows a moderate gain in the participants' performance, it shows a promising result compared to the traditional way of teaching. Thus, the developed approach can have a positive impact on learners, making this approach effective and relevant in science teaching.

5. CONCLUSIONS

Scientific literacy encompasses multiple dimensions, including procedural, functional, and conceptual learning. Educators can use various teaching approaches to enhance learners' scientific literacy in any science topic. In this study, the use of problem-based learning (PBL) with secondary resources in the form of published articles, videos, and recorded lectures is combined to create a science teaching approach called the "PBL-Resource Mining Approach." The main purpose of this study is to determine if this created teaching approach effectively uplifts learning competence in the environmental competency-atmospheric phenomena. Based on the results, the developed approach is effective in increasing scientific competence among the target participants compared to the traditional way of teaching.

However, results show that the participants have attained only a "fairly satisfaction" in their overall performance (referring to the experimental group). Though their performance is higher compared to the control group but the result indicates that PBL-Resource Mining allows learners to pass the competencies being tested barely. This result is further backed up by Hake's Gain analysis, wherein the experimental groups only attained a medium gain learning. Though the result shows that the experimental group has achieved moderate learning only, still the result shows that the PBL-Resource Mining Approach is effective compared to the traditional way of teaching. The result of this study implies that the developed approach can be used

in promoting scientific literacy, especially in environmental-related competencies.

To further improve this approach, the researchers consider the following modifications based on the observations made before, during, and after the implementation: first, the researchers acknowledge the diversity of learners in this study, therefore it is crucial to test the demographic profile of learners such as gender and their ethnicity. The researchers believed that these factors could have a significant impact in terms of their preference for learning. Second, learners' preparedness in PBL, as well as the use of technology. The researchers believed that these two factors are the main contributors in implementing the developed approach. Third, the language used by the downloaded secondary resources. Another factor that should be considered is the appropriateness of language. This can be due to the difficulty of words and dictions used in the videos and recorded lectures (the researchers used English language resources).

Another thing that should be considered is the implementation process (fourth). Based on the researcher's experience, 45 minutes is not enough. Therefore, the researchers believed that to integrate this strategy properly, the educator must limit the contents and duration of the activities to give way to the application of PBL. This way, the learners can have enough time to apply their learnings. Fifth and most important is the readiness of educators to implement PBL-resource mining. The researchers believed that though this approach is effective, it is still the responsibility of educators to implement this approach effectively to have a positive outcome. Overall, the researchers recommend using this developed approach in the promotion of scientific literacies, specifically in environmental-related competencies.

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