Improving Students' Science Literacy through the Use of Phenomenon-Based Advance Organizer Chemistry Learning Tools in Petroleum Material

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Abstract: The purpose of this study was to examine the improvement in science literacy after learning using appropriate chemistry learning tools with a phenomenon-based Advance Organizer model on the subject of petroleum. This study assesses the improvement in science literacy through quantitative description. Data collection was conducted at Puri 1 Senior High School in Mojokerto through pretest and posttest using science literacy questions through trial I on 36 students in class XII-1 and trial II on two classes, XII-5 and XII-8, each with 36 students. The research results showed that the science literacy test scores achieved an n-gain score ranging from 0.76, categorized as high, indicating that this learning tool is effective. The science literacy indicators with high n-gain scores were explaining phenomena scientifically (0.77) and constructing and evaluating designs for scientific investigations, as well as critically interpreting scientific data and evidence (0.78). While the last indicator was in the moderate category with an N-gain score of 0.66, which is researching, evaluating, and using scientific information for decision-making and action, so it needs to be improved in the future.

Keywords: Advance organizer; Learning tools; Phenomena; Science literacy

Introduction

Improving students' science literacy has become an urgent issue in Indonesian education, especially in an era where scientific knowledge is developing rapidly and becoming increasingly complex. Science literacy encompasses the ability to explain scientific phenomena, critique scientific evidence, and apply this knowledge in daily life to make rational, evidence-based decisions (Mulyani et al., 2023). Science literacy is also important in helping students understand various global issues such as climate change, energy sustainability, and the utilization of natural resources, which significantly impact their lives. Based on the results of Saija (2019) research, the science literacy of Indonesian students in

chemistry lessons shows that 77.95% of students are at a moderate level of science literacy. However, more recent data shows a significant decline, with the average science literacy score of Indonesian students in 2022 at 64.03%. In 2023, a further decline occurred, with the average score dropping to 45.8%, indicating that Indonesian students' science literacy is in the adequate category (Rohmaya et al., 2023; Sari et al., 2022). This decline highlights a significant gap between the expected standards of science literacy and student achievement, which requires immediate attention through more effective teaching approaches.

One of the causes of low science literacy among students is ineffective teaching methods when it comes to abstract and complex scientific concepts. For example,

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chemistry lessons on petroleum are often considered difficult for students to understand because they involve chemical concepts that are not easy to grasp without proper organization of knowledge. Research by Hartini (2024) shows that around 70% of students experience difficulties in understanding science topics related to energy and natural resources. Without a clear connection between scientific theory and real life, learning will feel distant and irrelevant to students. Therefore, it is important to develop a learning model that not only introduces scientific concepts but also connects them to relevant real-world experiences. This can help students see the practical applications of the science they are learning and understand the importance of these concepts in their daily lives.

In addressing this issue, the Advance Organizer learning model can be used as an effective solution. This model helps learners connect their existing knowledge with new information to be learned, thereby facilitating their understanding of more complex and abstract concepts. Research by Ausubel (1968) explains that the Advance Organizer aims to provide learners with an initial framework for thinking before the main material is taught, enabling them to connect new knowledge with existing knowledge. This strengthens learners' understanding of more complex and in-depth material. Research conducted by Yani et al. (2023) shows that the use of this model in chemistry learning can significantly improve students' critical thinking skills, which are an important component of science literacy. The use of Advance Organizers can enable students to not only memorize scientific concepts but also understand the relationships between various concepts and connect them to practical applications in school.

In addition to the Advance Organizer model, phenomenon-based learning can also improve students' science literacy. Phenomenon-based learning provides students with direct experiences that connect theory with real events happening around them. Research by (Nasor et al., 2023) shows that phenomenon-based learning is highly effective in connecting scientific concepts with everyday contexts and encouraging students to think critically and analytically. This approach teaches students not only to memorize theories but also to understand the application of scientific knowledge in real life. However, the phenomenon-based learning model has weaknesses if it is not supported by adequate knowledge organization. Without a clear structure to connect new knowledge with real-world experiences, students may struggle to understand more complex scientific phenomena (Syaharani et al., 2024). The combination of the Advance Organizer model and phenomenon-based learning offers the right solution to this problem. The use of Advance Organizers can provide the initial cognitive

framework needed to understand more complex scientific phenomena. Meanwhile, phenomenon-based learning provides a real-world context that motivates students to connect the knowledge they learn with their own experiences (Faresta et al., 2023; Santoso et al., 2023). This combination not only enhances students' theoretical understanding but also helps them apply the knowledge they have learned in their daily lives. In this context, the topic of petroleum is highly relevant for application in phenomenon-based learning because students can connect scientific concepts with energy and sustainability issues that are crucial in daily life.

Petroleum, as one of the materials often considered abstract and complex in chemistry lessons, requires a more applied and contextual approach. Understanding petroleum not only requires knowledge of chemical reactions but also an understanding of its connection to phenomena occurring in the students' surrounding environment, such as the environmental impact of fossil fuel use. Hidayati (2023) suggest that learning that combines theory with real-world phenomena can enrich students' learning experiences and enhance their understanding of difficult scientific concepts. By combining the Advance Organizer model and phenomenon-based learning, it is hoped that students can gain a deeper understanding of petroleum-related material and apply that knowledge in a broader global context, such as energy issues and sustainability.

The decline in Indonesia's science literacy scores as recorded in the 2018 PISA results shows that Indonesia ranks low in science literacy compared to other OECD member countries (OECD, 2019). Therefore, there needs to be a reform in the science education system that not only teaches scientific theory but also connects it to relevant real-world experiences. The combination of the Advance Organizer model and phenomenon-based learning can be one strategic step to improve the quality of science literacy in Indonesia because this approach allows students to connect theory with real-world applications and enhance critical thinking skills (Georgiou et al., 2023; Supriyadi et al., 2023).

This study aims to examine the effectiveness of using chemistry learning tools based on the Advance Organizer model combined with phenomenon-based learning in improving students' science literacy on petroleum material amid the challenges of low science literacy faced by Indonesian students. This study aims to contribute to the development of more effective and relevant learning models, which are expected to significantly improve students' science literacy (Elfeky et al., 2024).

Method

The subject of this study is a phenomenon-based advance organizer chemistry learning tool. The validated learning tool was then tested with an implementation schedule for the 2024/2025 academic year on 3 classes of grade XII students at Puri 1 senior high shcool, Mojokerto Regency. The development procedure consists of several steps in the 4D model development process, which involves four stages: define, design, develop, and disseminate (Lindl et al., 2020).
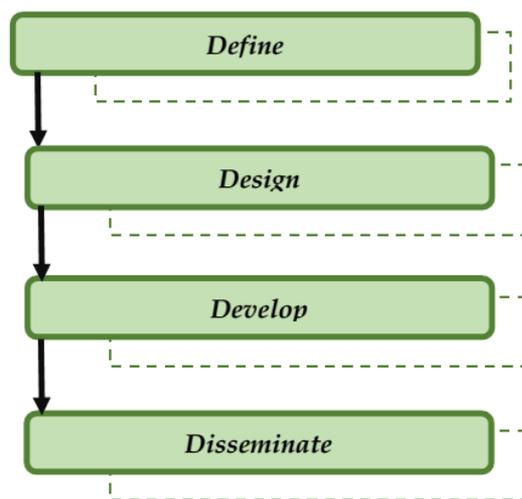

Figure 1. 4D Model research procedure chart

Test I was conducted on 36 students in grade XII, consisting of one class that had received petroleum material at Puri 1 senior high shcool, namely class XII-1. This test used a one group pretest-posttest design. The first phase began with a pretest to assess the students' initial science literacy levels. They were then exposed to instruction using the advance organizer-based phenomenon-driven chemistry learning tool, followed by a posttest to determine whether there was an improvement in their science literacy skills.

The second trial was conducted on 36 students in two Grade XII classes that had received petroleum-related material at Puri 1 senior high school, namely classes XII-5 and XII-8. This trial used a one-group pretest-posttest design to evaluate the learning tools after improvements were made based on the results of the first trial. The second trial can be used to assess the impact or effect of the developed learning tools. With a larger and more representative sample, it is hoped that these results can be used to draw more valid conclusions regarding the effectiveness or efficiency of the tested instrument (Nurrahman et al., 2019). The trial procedure was conducted over a certain period of time as shown in Figure 2.
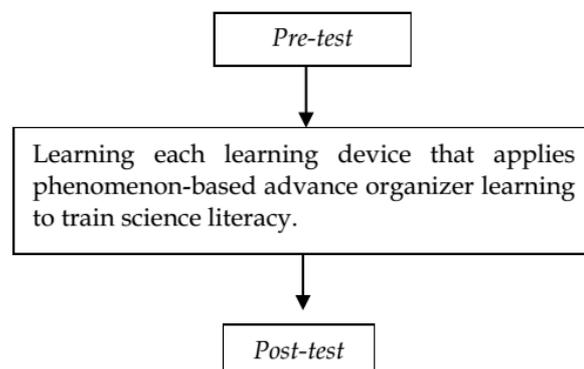

Figure 2. Research diagram with one group pretest-posttest design

Result and Discussion

The revised learning tools were then tested during three meetings for 36 students from SMAN 1 Puri, Mojokerto Regency, who were selected heterogeneously. The heterogeneous selection of students from class XII-1, both male and female, was based on the results of a pretest conducted on a different day from the test schedule. The students were randomly selected in a heterogeneous manner to represent the overall ability of students with varying levels of proficiency.

In this trial, a one-group pretest-posttest experimental design was used to compare the pretest scores before using the learning tools and the posttest scores after using the developed learning tools. The learning tools were tested to determine their effectiveness based on the results of the science literacy test and to determine their practicality based on the students' responses to the developed learning tools. The test results were obtained from tests conducted before and after using the developed learning tools. The test sheet was a science literacy test sheet. The science literacy test sheet aimed to determine the improvement in students' science literacy after using the learning tools. This test consisted of components of science literacy skills that were taught to students. The pilot study produced the following results:

Trial I

The science literacy pretest questions were given before the trial, and the science literacy posttest questions were given after the trial to determine the mastery of petroleum topics after using the learning tools. The results of the science literacy pretest and posttest are presented in Table 1.

The results of the science literacy pilot test I based on Table 1 show that all students have demonstrated an improvement in science literacy competencies after participating in the learning process. The average N-gain of the students was 0.75, which is considered high.

Therefore, with a high N-gain in trial I, the developed learning tools can be implemented in trial II. The comparison between the pretest and posttest of science literacy can also be seen in Figure 3.

Table 1. Science Literacy Results of Trial Test I for Grade XII-1

Name	N-gain	Category
S1	0.55	Moderate
S2	0.9	High
S3	0.67	Moderate
S4	0.86	High
S5	0.66	Moderate
S6	0.74	High
S7	0.39	Moderate
S8	0.68	Moderate
S9	0.93	High
S10	1	High
S11	0.31	Moderate
S12	0.79	High
S13	0.56	Moderate
S14	0.72	High
S15	0.86	High
S16	0.43	Moderate
S17	0.53	Moderate
S18	0.85	High
S19	0.76	High
S20	1	High
S21	0.88	High
S22	0.86	High
S23	0.83	High
S24	1	High
S25	0.69	Moderate
S26	0.56	Moderate
S27	0.51	Moderate
S28	0.56	Moderate
S29	0.71	High
S30	0.69	Moderate
S31	0.72	High
S32	0.76	High
S33	0.78	High
S34	0.89	High
S35	0.95	High
S36	0.67	Moderate
Average	0.75	High

Improving students' science literacy in chemistry learning can be achieved through an approach that connects prior knowledge with more complex new material. One effective model in this context is the advance organizer, first introduced by Muamanah (2020). This model serves to provide an initial cognitive structure that enables students to organize new information and relate it to their prior knowledge. In the context of chemistry learning, especially complex topics such as petroleum, the use of advance organizers has been proven to improve understanding and retention of material. This is in line with the results of research

conducted by Yani et al. (2023) which showed that the use of this model can strengthen the relationship between existing knowledge and the material being studied, thereby improving students' cognitive learning outcomes. This approach has not only proven effective in science education at the junior high school level but can also be adapted well for more complex chemistry topics like petroleum, which require a deep understanding of the chemical processes occurring in nature. In the first pilot study in class XII-1, all students experienced a significant improvement in science literacy after participating in the learning process using the phenomenon-based advance organizer model. Research by Teng (2022) supports this finding by showing that advance organizers can improve students' conceptual understanding in learning, a principle that can be applied in chemistry learning. In the context of petroleum, the application of this model allows students to connect their knowledge of geological processes with real-world applications in petroleum production. The results of the first trial showed an average N-gain of 0.75, categorized as high, proving that this model effectively improves students' science literacy.

In addition to advance organizers, phenomenon-based approaches also play an important role in improving students' science literacy. Phenomenon-based learning allows students to connect scientific concepts with real phenomena that occur in their surroundings. For example, in learning about petroleum, phenomena related to the use of petroleum in everyday life can be used as a starting point for building scientific understanding. According to Syaharani (2024) phenomenon-based learning can increase student engagement because they find it easier to relate scientific concepts to their real-world experiences. However, this approach also has a drawback: it may be less effective if students lack the necessary prior knowledge to connect phenomena with relevant scientific concepts. In this case, combining phenomenon-based advance organizers is an effective solution. This approach provides the initial cognitive framework needed to understand complex scientific phenomena and enables students to not only understand theory but also apply it in real-world contexts so that they can develop higher science literacy skills. The phenomenon-based learning model used in trial I focused students on observing scientific phenomena that occur in the real world, such as the process of petroleum refining. In line with the results of research by Ferreira (2021) the phenomenon-based approach facilitates students' active engagement with natural phenomena, which enhances their understanding of relevant scientific concepts. However, the phenomenon-based model can be less effective without adequate knowledge organization. This

approach must be supported by a clear cognitive framework to connect new knowledge with prior knowledge. In trial I, the application of a phenomenon-based advance organizer enabled students to more easily connect their prior knowledge of geology with the petroleum phenomena they were studying, thereby enhancing their understanding of this complex topic.
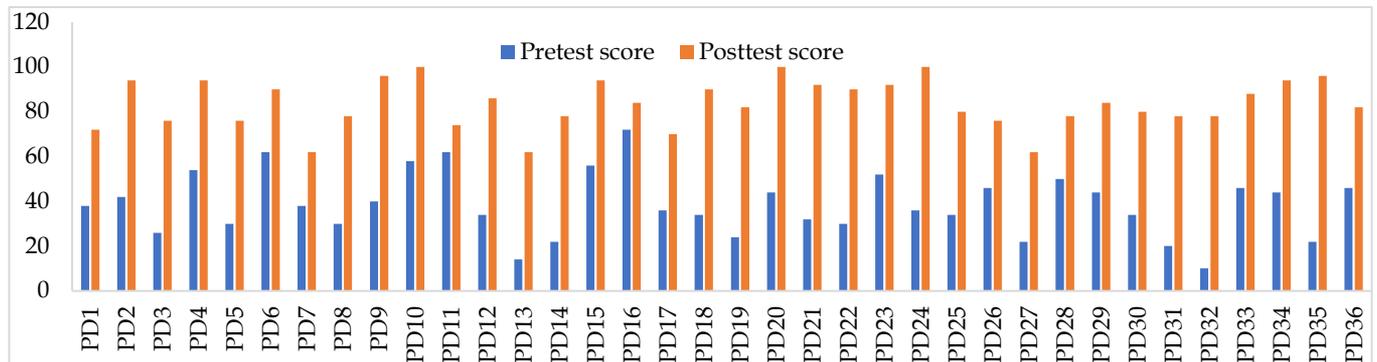

Figure 3. Comparison chart of pretest and posttest scores for trial I

The advance organizer model has been proven to improve in-depth conceptual understanding because learners are encouraged to connect existing knowledge with new information they are learning. This approach not only aids in mastering the material but also improves long-term information retention. Choudhary (2015) state that the use of advance organizers can improve students' understanding and retention of material, especially in chemistry learning that involves abstract concepts. Advance organizers are used to introduce chemistry concepts before students study the material further. This makes it easier for students to understand and remember the information. The application of this model in petroleum education enables students to build a solid framework of thinking and, in turn, improves their understanding of the material being studied. Furthermore, this deeper understanding enables students to more easily remember complex chemistry concepts that are crucial in topics like petroleum, where many chemical phenomena are related to large-scale natural processes and require comprehensive understanding (Choudhary et al., 2015). The results of the data analysis from Experiment I indicate that the application of the advance organizer enhances students' understanding of chemical concepts related to petroleum. As explained by Weymuth et al. (2021) the use of simulations and virtual reality technology combined with the advance organizer model can facilitate students' understanding of abstract chemical concepts. This aligns with the results of Experiment I, where students using this model found it easier to remember and understand the chemical processes involved in the formation and utilization of petroleum. Adipat (2024) also demonstrated that phenomenon-based learning models, which connect theoretical knowledge with real-world experiences, enhance student engagement, which in turn improves their understanding of the taught material. Therefore, the use of a phenomenon-based advance organizer model in petroleum education has proven effective in improving understanding and retention of complex chemical material.

Table 2. Results of Science Literacy Recapitulation for Each Indicator of Trial Test I for Grade XII 1

Science Literacy Indicators	N-gain	Category
Explain phenomena scientifically	0.75	High
Construct and evaluate designs for scientific investigations and interpret scientific data and evidence	0.76	High
Research, evaluate, and use scientific information for decision-making and action	0.61	Moderate

Based on the results of trial I conducted in class XII-1, all students showed a significant increase in science literacy after participating in the learning process using the phenomenon-based advance organizer model. The results of the pretest and posttest of science literacy showed a significant difference in the mastery of petroleum material, with an average N-gain of 0.75, which is categorized as high. This indicates that the implementation of this learning model successfully improved students' science literacy significantly. Previous research by Salleh (2024) also supports this finding, as they found that computational thinking-based models can enhance students' critical thinking skills. The use of advance organizers by students can connect new knowledge with prior knowledge, which plays an important role in improving their science literacy. Therefore, this learning model is highly effective in helping students understand complex

material such as petroleum, which requires a comprehensive understanding of the chemical processes occurring in nature. The results of trial I in class XII-1 showed that the phenomenon-based advance organizer model was effective in improving students' science literacy. This supports the findings reported by Yanto & Sari (2025), which showed that the integration of phenomenon-based models and advance organizers can improve students' deep understanding of scientific concepts. Research by Pebrianti (2024) also found that the use of learning that integrates a phenomenon-based approach can improve students' critical thinking skills and science literacy. In the context of trial I, students were able to connect scientific concepts with real phenomena in their daily lives, such as the petroleum processing process, which enriched their understanding of the topic.

The results of the analysis of the science literacy recapitulation in trial I show that the learning model used is effective in improving students' competencies in various science literacy indicators. The indicators showing the most significant improvement are the first science literacy indicator, which is explaining phenomena scientifically, and the second indicator, which is constructing and evaluating designs for scientific investigations, both of which obtained N-gains of 0.75 and 0.76, respectively, which fall into the high category. This improvement indicates that students can more easily explain and construct scientific knowledge after using the advance organizer model. Research conducted by Mulyani et al. (2023) emphasizes that science literacy-based models are effective in improving students' ability to design experiments and interpret scientific data. In the context of chemistry learning, such as in petroleum material, this model helps students organize information and scientific concepts in a more structured way so that they can relate theory to real-world phenomena such as the process of petroleum formation and its impact on the environment. This aligns with findings by Zhang (2023), which show that advance organizer models help students connect existing knowledge with new material. Thus, this model is highly relevant for enhancing students' science literacy in chemistry topics like petroleum, which involve understanding theories and their practical applications in real life.

In addition to improving conceptual understanding, the use of phenomenon-based advance organizers also helps students develop critical thinking skills. This approach provides students with the opportunity to engage directly with scientific phenomena relevant to their lives, enabling them to analyze and solve scientific problems in a more in-depth and critical manner (Widowati et al., 2023). Yani (2023) revealed that this model is effective in improving critical thinking skills, especially when used to connect prior knowledge with new information. In chemistry learning, the application of this model allows students to see the relationship between chemical theory and natural phenomena occurring around them, such as the extraction and utilization of petroleum. This encourages them to think more critically about the impact of petroleum use on the environment and energy sustainability in the future. Phenomenon-based learning also plays an important role in developing students' critical thinking skills. In trial I, students were invited to observe and analyze phenomena that occur in real life, such as the role of petroleum in the global economy and its impact on the environment. As explained by Sunasuan & Songserm (2021), the use of the advance organizer model in a collaborative classroom can increase student engagement and help them think critically about scientific issues relevant to their lives. This phenomenon-based approach enables students to think more critically about the utilization of natural resources such as petroleum, as well as the impact of its use on the environment and energy sustainability. Therefore, the integration of the phenomenon-based advance organizer model can enhance students' critical thinking skills, particularly in the learning of more complex chemistry material.

The advance organizer model focuses not only on conceptual understanding but also on long-term knowledge retention. Research findings by Pratama (2025) indicate that the use of advance organizers in learning can significantly improve students' information retention. This model helps students organize and remember scientific concepts in a more systematic way, enabling them to recall and understand the taught material more easily. In addition, this improved retention enables students to be better prepared for exams or in-depth tests that assess their understanding of complex chemistry material. In addition to improving understanding, the phenomenon-based advance organizer model has also been proven effective in improving knowledge retention. Research by Thahir (2020) shows that this model helps students organize information and remember scientific concepts better. The results of trial I indicate that students who use this model have a better ability to retain the knowledge they have learned, which aligns with the findings reported by Kusdiastuti (2020), who emphasize the importance of advance organizers in helping students remember the scientific concepts they have learned. Therefore, the phenomenon-based advance organizer model not only enhances understanding but also improves knowledge retention among students in chemistry learning.

Based on the results of trial I and existing literature, the use of a phenomenon-based advance organizer model can be an effective strategy in chemistry learning,

especially for complex material such as petroleum. This model not only helps students understand chemistry concepts but also connects them to real-life experiences they encounter around them. Therefore, further development of this model is highly recommended, considering the increased integration of technology and the development of learning media that can enhance its effectiveness in teaching science literacy. As explained by Valladares (2021) science education must involve social change and critical awareness of science issues relevant to the social lives of students, such as environmental issues related to the use of petroleum. The phenomenon-based advance organizer model can help students develop critical thinking skills and responsible solutions to global issues. As stated by Hanč (2024) the integration of technology in science learning can enhance students' learning experiences, which is highly relevant in teaching abstract chemistry concepts. Therefore, further development of the phenomenon-based advance organizer model can help improve students' science literacy and prepare them to face global challenges related to complex scientific issues such as the use and sustainability of natural resources.
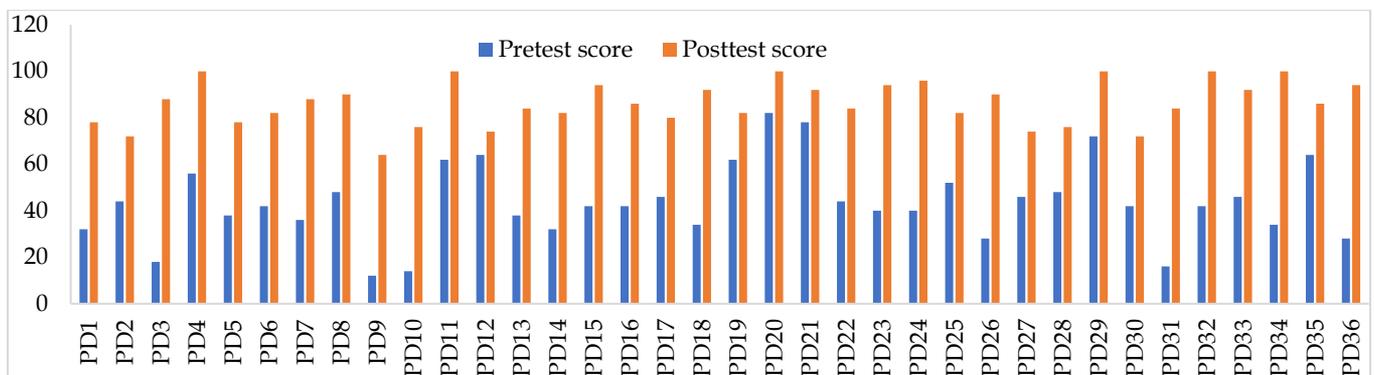
Trial II

The science literacy test in trial II was conducted in two classes with a total of 36 students in class XII-5 and 36 students in class XII-8. The science literacy test was conducted twice. The first test was conducted before instruction (pretest), and the second test was conducted after instruction using the Advance Organizer assisted by Phenomena (posttest) learning model. Students' science literacy proficiency can be seen in Table 3.

The science literacy results of the second pilot study for class XII-5, as shown in Table 3, indicate that all students demonstrated an improvement in science literacy competencies after participating in the learning process. The average N-gain of the students was 0.78, which is considered high. Eight students achieved a moderate N-gain category, and 36 students achieved a

high N-gain category. The comparison of pretest and posttest scores obtained by the students in class XII-5 can be seen in Figure 4.

Table 3. Science Literacy Results of Trial Test II for Grade XII-5

Name	N-gain	Category
S1	0.68	Moderate
S2	0.5	Moderate
S3	0.85	High
S4	1	High
S5	0.64	Moderate
S6	0.69	Moderate
S7	0.81	High
S8	0.80	High
S9	0.59	Moderate
S10	0.72	High
S11	1	High
S12	0.28	Low
S13	0.74	Moderate
S14	0.74	High
S15	0.89	High
S16	0.76	High
S17	0.63	Moderate
S18	0.88	High
S19	0.53	Moderate
S20	1	High
S21	0.64	Moderate
S22	0.71	Moderate
S23	0.9	High
S24	0.93	High
S25	0.62	Moderate
S26	0.86	High
S27	0.52	Moderate
S28	0.54	Moderate
S29	1	High
S30	0.52	Moderate
S31	0.81	Moderate
S32	1	High
S33	0.85	High
S34	1	High
S35	0.61	Moderate
S36	0.92	High
Average	0.77	High

Figure 4. Comparison chart of pretest and posttest scores for trial II in class XII 5

Table 4. Results of Science Literacy Recapitulation for Each Indicator of Trial Test II for Grade XII 5

Science Literacy Indicators	N-gain	Category
Explain phenomena scientifically	0.80	High
Construct and evaluate designs for scientific investigations and interpret scientific data and evidence	0.84	High
Research, evaluate, and use scientific information for decision-making and action	0.63	Moderate

Figure 4 shows that all students in class XII-5 experienced an increase from the pretest to the posttest after participating in the Advance Organizer model assisted by phenomena, with each student experiencing a different increase from one another. The results of the second class test are shown in Table 5.

Table 5. Science Literacy Results of Trial Test II for Grade XII-8

Name	N-gain	Category
S1	0.83	High
S2	0.93	High
S3	0.78	High
S4	0.67	Moderate
S5	0.61	Moderate
S6	0.89	High
S7	0.59	Moderate
S8	0.64	Moderate
S9	0.85	High
S10	0.61	Moderate
S11	0.69	Moderate
S12	0.87	High
S13	0.89	High
S14	0.71	High
S15	0.5	Moderate
S16	0.79	High
S17	0.74	High
S18	0.89	High
S19	0.63	Moderate
S20	0.78	High
S21	0.55	Moderate
S22	0.87	High
S23	0.75	High
S24	0.23	Low
S25	0.59	Moderate
S26	0.89	High
S27	0.61	Moderate
S28	1	High
S29	0.82	High
S30	0.78	High
S31	0.61	Moderate
S32	1	High
S33	0.86	High
S34	0.90	High
S35	0.78	Moderate
S36	0.85	High
Average	0.75	High

The results of the science literacy test II for class XII-8 based on Table 5 show that all students demonstrated an improvement in science literacy competencies after participating in the learning process. The average N-gain for students was 0.75, which is considered high. The comparison of pretest and posttest scores obtained by students in class XII-8 can be seen in Figure 5. Figure 5 shows that all students in XII-8 experienced an increase from the pretest to the posttest after participating in the advance organizer model assisted by Phenomena, with each student experiencing a different increase from one another. The results of the second science literacy test were reviewed based on the science literacy competencies of the students, which included three literacy indicators. The average total pretest score for the two sample classes with an N-gain of 0.77 was categorized as high, indicating that, overall, the advance organizer model assisted by Phenomena can improve students' science literacy.

In trial I, the application of the phenomenon-based advance organizer model showed encouraging results, with an average N-gain of 0.75, indicating a significant improvement in students' science literacy. However, there are several aspects that need to be improved to strengthen learning outcomes, such as variations in students' levels of understanding of each science literacy indicator. Based on the results of Trial I, improvements are needed by providing more concrete examples relevant to the phenomenon of petroleum. Research by Bryce (2024) shows that videos in advance organizers can help clarify the relationship between new knowledge and existing knowledge, thereby enriching the learning process. Improving the learning materials by introducing more phenomena related to petroleum and increasing student engagement in phenomenon-based learning will be the main focus of Trial II. It is hoped that Trial II will show better and more consistent results in enhancing students' science literacy more broadly.

In Trial II, conducted in classes XII-5 and XII-8, students demonstrated a significant improvement in science literacy, with an average N-gain of 0.77 and 0.75, respectively, which is categorized as high. This indicates that the phenomenon-based advance organizer model is effective in enhancing students' understanding and science literacy skills. Based on the data in Table 3 and Table 5 for trial II, the N-gain scores show that most students achieved a high category. Research by Klomim (2024) supports this finding, stating that phenomenon-based learning and advance organizers can enhance students' critical thinking and problem-solving skills in a science context. The improvement in science literacy in Trial II also indicates that learning involving real phenomena such as petroleum can enrich deeper

scientific concept understanding, as explained by Diab (2024).

The average science literacy scores obtained by students in trial II showed significant results. In class XII-5, the average N-gain reached 0.77, while in class XII-8, the average N-gain was 0.75. These results indicate that learning using the phenomenon-based advance organizer model successfully improved students' science literacy, particularly in the indicators of explaining scientific phenomena, constructing scientific

investigation designs, and using scientific information for decision-making. Sibela (2024) stated that the advance organizer model enhances students' critical and analytical thinking skills by providing a clear framework for processing new information. In Trial II, students were able to connect their prior knowledge of hydrocarbons with more complex chemical concepts such as the formation and utilization of petroleum, demonstrating the effectiveness of this model in enhancing overall science literacy (Djaen et al., 2021).
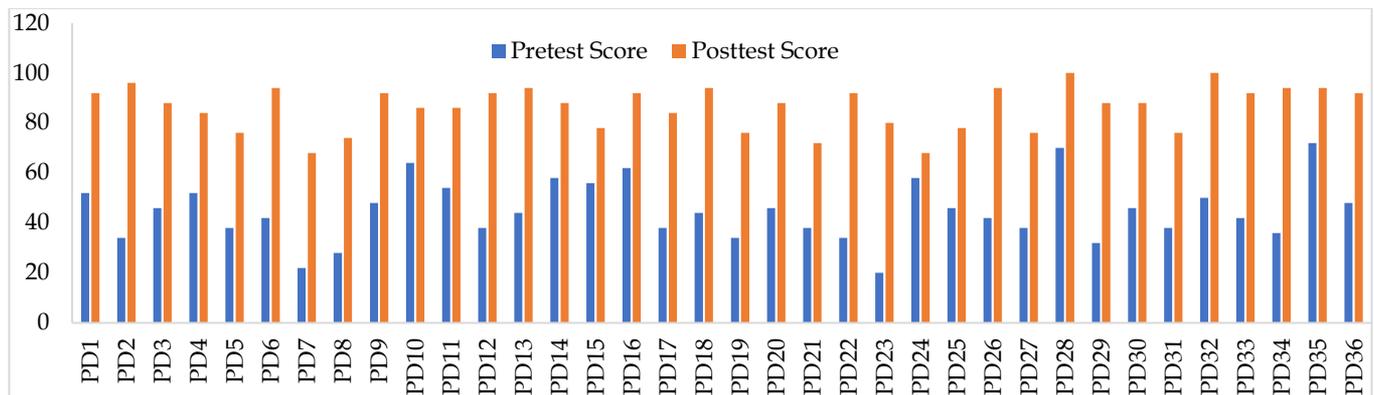

Figure 5. Comparison chart of pretest and posttest scores for trial II in class XII 8

Table 6. Results of Science Literacy Recapitulation for Each Indicator of Trial Test II for Grade XII 8

Science Literacy Indicators	N-gain	Category
Explain phenomena scientifically	0.76	High
Construct and evaluate designs for scientific investigations and interpret scientific data and evidence	0.75	High
Research, evaluate, and use scientific information for decision-making and action	0.75	High

An analysis of the science literacy recapitulation results based on indicators in trial II shows that most students achieved high N-gains on the indicators of explaining phenomena scientifically and constructing and evaluating designs for scientific investigations, as well as interpreting scientific data and evidence, with N-gains of 0.80 and 0.84, respectively, in class XII-5. In class XII-8, similar results were found with indicators showing high N-gains, particularly in indicators related to understanding scientific phenomena and scientific investigation. This aligns with research by Purnawati (2024) which indicates that learning that integrates real-world phenomena can enhance students' science literacy skills, especially in learning that requires understanding complex scientific concepts. However, indicators related to researching, evaluating, and using scientific information for decision-making and action showed lower N-gains, namely 0.63 in class XII-5 and 0.75 in class XII-8, indicating that some students still face difficulties in integrating their knowledge for more applied actions.

Some students in trial II obtained moderate N-gains, particularly in the indicators of researching, evaluating, and using scientific information for decision-

making and action. In class XII-5, 8 students achieved moderate N-gain, while in class XII-8, 6 students achieved the same category. This may be due to several factors, such as students' limited ability to connect the theories they have learned with practical applications in the real world. Hidayati (2023) state that the success of the advance organizer model in improving students' understanding depends heavily on their ability to connect theoretical knowledge with real-world experiences. Therefore, it is recommended to introduce more hands-on experiences through phenomenon-based discussions or the use of technology that can enrich the learning context and help students better understand how theories are applied in real-world practice.

A comparison between the results of trial I and trial II shows a significant improvement in students' science literacy. In trial I, the average N-gain reached 0.75, while in trial II, the average N-gain increased to 0.77 and 0.75 in classes XII-5 and XII-8. Sutiani (2021) argues that science literacy can be significantly improved through an approach that involves problem-solving based on conceptual understanding rather than mere memorization. This improvement indicates that the phenomenon-based advance organizer model is not

only effective for mastering scientific concepts theoretically but also enables students to connect their knowledge with real-world experiences such as oil phenomena. The more structured application of this model and the refinement from trial I to trial II yielded more consistent and deeper results in improving overall science literacy.

Conclusion

Based on research data and analysis of learning tools to improve science literacy on the topic of petroleum, the feasibility was demonstrated. This was obtained from the effectiveness results in the form of science literacy test scores, with the developed learning tools deemed effective for use. The results are based on science literacy test scores, which showed an increase with N-gain scores ranging from 0.76 in the high category. The hope is to maximize the third science literacy indicator, which is researching, evaluating, and using scientific information for decision-making and action, so that students can practice science literacy questions to the fullest and achieve better improvement.

Author Contributions
A.N.W: Conceptualization, methodology, development of learning tools, analysis, manuscript writing, revision, visualization. R.A: Conceptualization, guidance during research, manuscript writing. S.S: Guidance during research, manuscript writing.

Conflicts of Interest
The authors declare that there are no conflicts of interest in this research.

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