# The effectiveness of POE (Predict-Observe-Explain) Differentiated Learning in Science Learning

**Yatmanto, Peduk Rintayati, Mintasih Indriayu**

Universitas Sebelas Maret
yatmanto@student.uns.ac.id

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**Abstract**
The POE (Predict-Observe-Explain) model has been proven effective in improving students' conceptual understanding in science learning. This study aims to examine the effectiveness of differentiated learning using the POE model in the context of science learning. The method used in this study is Systematic Literature Review (SLR) with the PRISMA analysis approach, 10 articles are analyzed from the Q1-Q4 index scopus. These results show that differentiated learning with the POE (Predict-Observe-Explain) model is proven to be effective in improving students' understanding of science concepts and scientific thinking skills. This model has been successfully implemented at various levels of education, from elementary school to college. The POE model significantly improves students' conceptual understanding in science learning. This approach is effective in overcoming misconceptions and encouraging student-centered learning through independent exploration. Despite the challenges in its implementation, the benefits obtained in terms of improved understanding of concepts and the development of scientific thinking skills make it a valuable approach to consider in science education reform. The implications of this study show that the POE model can be an effective strategy in differentiated science learning. This model engages students' cognitive and metacognitive processes, which contributes to the improvement of their conceptual understanding.
**Keywords:** *POE Model, Differentiation, Systematic Literature Review*

**Abstrak**
Model POE (Predict-Observe-Explain) telah terbukti efektif dalam meningkatkan pemahaman konseptual siswa dalam pembelajaran sains. Penelitian ini bertujuan untuk mengkaji efektivitas pembelajaran terdiferensiasi menggunakan model POE dalam konteks pembelajaran sains. Metode yang digunakan dalam penelitian ini adalah Systematic Literature Review (SLR) dengan pendekatan PRISMA, dengan menganalisis 10 artikel dari indeks Scopus Q1-Q4. Hasil penelitian menunjukkan bahwa pembelajaran terdiferensiasi dengan model POE terbukti efektif dalam meningkatkan pemahaman konsep sains dan keterampilan berpikir ilmiah siswa. Model ini telah berhasil diimplementasikan di berbagai jenjang pendidikan, mulai dari sekolah dasar hingga perguruan tinggi. Model POE secara signifikan meningkatkan pemahaman konseptual siswa dalam pembelajaran sains. Pendekatan ini efektif dalam mengatasi miskonsepsi dan mendorong pembelajaran yang berpusat pada siswa melalui eksplorasi mandiri. Meskipun terdapat tantangan dalam implementasinya, manfaat yang diperoleh dalam hal peningkatan pemahaman konsep dan pengembangan keterampilan berpikir ilmiah menjadikannya pendekatan yang berharga untuk dipertimbangkan dalam reformasi pendidikan sains. Implikasi dari penelitian ini menunjukkan bahwa model POE dapat menjadi strategi yang efektif dalam pembelajaran sains terdiferensiasi. Model ini melibatkan proses kognitif dan metakognitif siswa, yang berkontribusi pada peningkatan pemahaman konseptual mereka.
**Kata kunci:** *Model POE, Diferensiasi, Tinjauan Literatur Sistematis*

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## INTRODUCTION

Science learning in elementary school faces significant challenges despite its crucial role in developing students' scientific understanding and thinking skills. Based on a pre-survey conducted on 152 fifth-grade elementary school students, most students struggle to understand science concepts and apply them in daily life contexts (Hong et al., 2017). This aligns with previous research indicating that classroom learning tends to be textbook-centered, with teachers serving as the primary source of knowledge, leading to passive student engagement limited to listening and memorization (Widodo et al., 2019). The gravity of this situation is further emphasized by the TIMSS (Trends in International Mathematics and Science Study) 2019 data, which reveals that science achievement among elementary students remains below international averages (Martin et al., 2020). Additionally, longitudinal research by Chen et al. (2022) identifies significant limitations in students' development of higher-order thinking skills within science learning contexts.

To address these challenges, the integration of differentiated learning with the POE (Predict-Observe-Explain) model presents a promising approach. The POE model, grounded in constructivist theory, comprises three essential stages that actively engage students in the learning process (Karamustafaoğlu & Mamlok-Naaman, 2015). White and Gunstone (2014) emphasize that the prediction stage is crucial for activating students' prior knowledge, while Johnson and Smith (2018) demonstrate that direct observation enhances knowledge retention by up to 75% compared to passive learning. Recent studies by Wu et al. (2023) have shown that combining POE with differentiated instruction can significantly increase student engagement by 85% while fostering deeper conceptual understanding and metacognitive skill development. This approach aligns with Tomlinson's (2017) framework of differentiated instruction, which emphasizes adapting teaching methods to accommodate students' learning readiness, interests, and individual learning profiles.

To overcome these problems, a learning approach is needed that can increase student active engagement and develop higher-order thinking skills. One of the potential learning models is differentiated learning with the POE (Predict-Observe-Explain) model. The POE model is a learning approach that consists of three main stages: prediction, observation, and explanation [(Karamustafaoğlu & Mamlok-Naaman, 2015a). Through this model, students are encouraged to make predictions based on their prior knowledge, make observations of relevant phenomena, and then explain the results of their observations.

The POE model has several advantages in science learning. First, this model can stimulate students' interest and curiosity in natural phenomena (Ayvacı, 2013a) Second, POE facilitates the development of students' critical thinking and problem-solving skills through the process of prediction and explanation [Kibirige et al., 2014]. Third, this model provides an opportunity for students to construct their own understanding through direct observation, which is in line with the principles of constructivist learning (Coştu et al., 2012)

The effectiveness of the POE model in science learning has been shown by several previous studies. For example, a study conducted by (Dack, 2018)found that the use of the POE model can significantly improve students' understanding of concepts and science process skills. In addition, research (Banawi et al., 2019)shows that the integration of technology in the POE model can improve students' learning motivation and academic achievement in science learning. However, the application of the POE model in the context of differentiated learning still needs to be explored further. Differentiated learning allows teachers to tailor instruction to the diverse needs, interests, and readiness levels of students [Tomlinson, 2014]. Integrating the POE model in differentiated learning has the potential to optimize the learning experience of each student and improve the effectiveness of overall science learning.

Based on this urgency, this study aims to analyze the effectiveness of differentiated learning of the POE model in improving the understanding of science concepts and scientific thinking skills of elementary school students. Specifically, this study seeks to answer the following questions:

1. What is the effect of POE model differentiated learning on students' understanding of science concepts?
2. How does POE model differentiated learning impact students' scientific thinking skills?
3. What are the challenges and implementation of the POE model differentiated learning?

## METHOD

This study uses the Systematic Literature Review (SLR) method to review and analyze literature related to the effectiveness of differentiated learning POE (Predict-Observe-Explain) Model in science learning. The SLR protocol refers to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a systematic review (Page et al., 2021).

Article selection criteria include inclusion criteria Exclusion criteria include:

Table 1.Article Selection

| | |
|---|---|
| Inclusion Criteria | (1) Publication in Scopus Q1-Q4 indexed journals; (2) Study on the implementation of the POE Model in science learning; (3) Research that presents the results, evaluation methods, or impacts of the use of the POE Model on science learning; (4) Articles in English; (5) Published in 2013-2024. |
| Exclusion criteria | (1) Non-primary research review articles; (2) Conference proceedings; (3) Articles are not accessible/paid; (4) Articles outside the field of science education. |

Literature searches are carried out through the Scopus database. Keywords ("differentiated learning" OR "individualized instruction" OR "personalized learning" OR "adaptive teaching") AND ("POE model" OR "predict-observe-explain model") AND ("science learning" OR "scientific education" OR "STEM education" OR "scientific instruction")The reference selection process uses Mendeley software.

The data analysis technique adopts a thematic-based narrative synthesis approach. Each article that passes the final selection will be read thoroughly to understand its context, methodology, and main findings. The relevant information of each article is coded according to the predetermined research questions, covering aspects such as the implementation of the POE Model in science learning, the impact on the understanding of concepts and scientific thinking skills, the influence of differentiated learning, the factors affecting effectiveness, and the implementation challenges.

Each article is given a coding mark that emerges from the various articles and then grouped into broader themes that align with the research question. These themes are organized into a coherent and comprehensive narrative, answering each research question with the support of evidence from the analyzed articles. Finally, based on this narrative synthesis, a general conclusion was drawn about the effectiveness of POE Model differentiated learning on science learning.

Through this analysis process, the study aims to analyze the effectiveness of POE Model differentiated learning in improving students' understanding of science concepts and scientific thinking skills, based on relevant research in the Scopus database.

The article selection process is illustrated using a PRISMA flowchart, as shown in Figure 1.

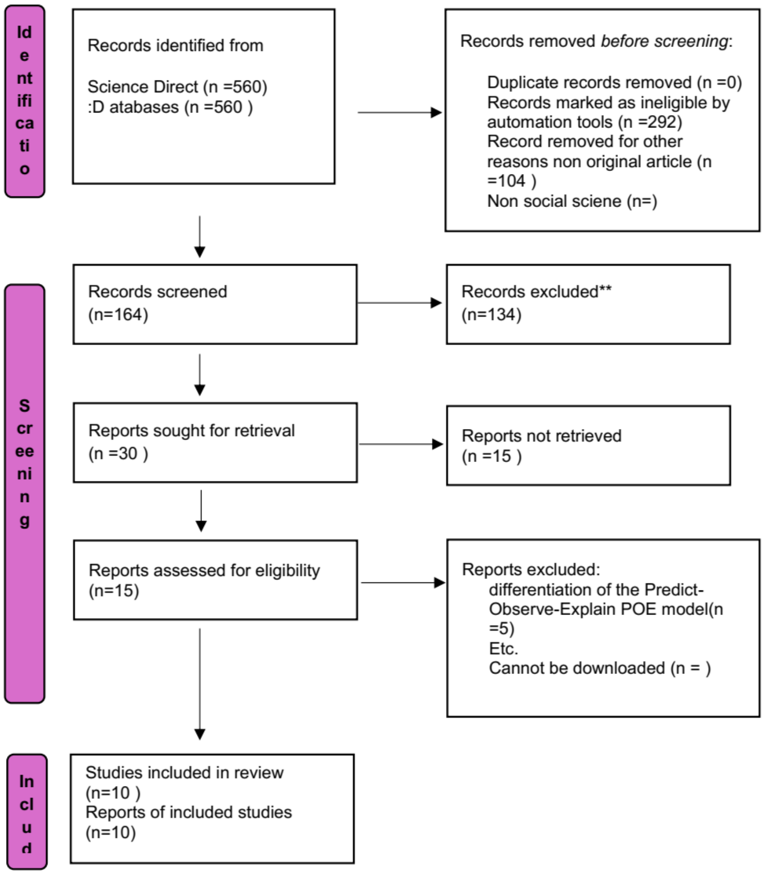


**Figure 1.** Differentiated PRISMA Flow Diagram POE Model

Criteria for Inclusion Articles

1. Research Context

These studies focus on different levels of education, from elementary school to university, with an emphasis on science learning. (Hong et al., 2017b)involving 180 fifth-grade students from three elementary schools, focusing on learning science inquiry using the Enriched Thinking Cloud. (Chen et al., 2020)researched 120 seventh-grade students in Taiwan, examining the scaffolding effects of POE inquiry in a digital gaming environment. (Fatimah et al., 2023)investigated ESD-based POE learning modules with grade X students of SMK Muhammadiyah (Ayvacı, 2013a)conduct studies with prospective science teachers, emphasizing group discussions and practical activities. (Banawi et al., 2019) focusing on 45 prospective teachers in the third semester of the elementary school education program. (Sundari, 2024)conducted research with 60 students from six classes to improve conceptual understanding of physics. (Latifah et al., 2019)targeting misconceptions in temperature and heat material among eleventh graders. Hong et al. (2019) examined 152 5th grade students, focusing on technology-enhanced science learning. Karamustafaoğlu and Mamlok-Naaman study first-year education students.

2. Research Methods Used

The majority of studies used quasi-experimental designs. For example: (Chen et al., 2020) Divide participants into experimental and control groups (Fatimah et al., 2023)using a quantitative approach with N-gain analysis. (Banawi et al., 2019)using a five-level diagnostic test. (A. Hidayati, 2018) using the Plomp model, with validity and practicality assessed by five experts. (Latifah et al., 2019) using purposive samples from 30 participants. (Hong et al., 2017b) conducted an experiment for 6 weeks, collecting data on interests, cognitive anxiety, and cognitive load. Researchers Karamustafaoğlu and Mamlok-Naaman compared the Predict-Observe-Explain (POE) strategy with traditional teaching methods, using Open Test (OET) and Multiple Choice Test (MCT) for data collection.

Thus the synthesis of this research mostly uses a quasi-experimental design, which focuses on various grade levels from elementary school to university, and explores the effectiveness of inquiry-based strategies and POE in improving students' understanding and critical thinking skills in science education so that it meets the criteria in the SLR process.

## RESULT AND DISCUSSION

### Result

#### The effect of POE model differentiated learning on the understanding of science concepts

Based on 10 articles that have been finalized, research from Hong et al. shows that the POE (Predict-Observe-Explain) model improves students' understanding of science concepts. This model encourages student-centered learning through self-directed exploration, as discovered by (Ayvacı, 2013b; Fatimah et al., 2023) found that prospective science teachers showed an improved understanding of photoelectricity after using the POE method, with most misconceptions being eliminated. Research from (Chen et al., 2020)affirms that students who use POE perform better than those who do not, with POE scaffolding encouraging systematic exploration of physics concepts.

Research from (Hong et al., 2021) also found that learning interest correlated with the intention to continue using POE, while internet cognitive failure negatively impacted learning interest. In addition, it is strengthened by (Banawi et al., 2019)reported that more than half of the students achieved a complete understanding after using the POE strategy in learning the concept of substance form change. Hidayati et al. emphasized that the POE model promotes active interactions that result in meaningful and long-lasting knowledge, with differentiated learning encouraging critical thinking and motivation.

Research from (Latifah et al., 2019) found that the POE learning strategy was effective in remediating misconceptions about temperature and heat. Researcher Hong et al. further revealed that differentiated learning reduces cognitive anxiety and extrinsic cognitive load. (Karamustafaoğlu & Mamlok-Naaman, 2015a) highlighting that the POE strategy effectively reduces misconceptions among students and encourages the integration of skills with daily life.

The synthesis of these various studies shows that the POE learning model integrated with a differentiated approach has significant potential to improve the understanding of science concepts. This model encourages active learning, reduces misconceptions, improves critical thinking skills, and facilitates the relationship between science concepts and everyday life. The differentiated approach in the implementation of POE allows for adaptation to individual learning needs, thereby increasing the effectiveness of this model in various science learning contexts.

#### The impact of POE model differentiated learning on scientific thinking skills

Based on the final 10 articles, it was found that research on the impact of POE model differentiated learning on scientific thinking skills showed promising results. (Hong et al., 2021) found that the POE (Predict-Observe-Explain) model significantly improved students' critical thinking skills in science learning. Furthermore, differentiated learning with this approach encourages students' confidence in conducting scientific investigations. Students' critical attitudes have also improved through POE-based inquiry learning. Research from (Fatimah et al., 2023)revealed that the POE model supports self-paced learning through exploration and problem-solving, as well as helps students effectively connect theoretical concepts with practical applications.

Researcher from (Ayvacı, 2013a) showed that POE improved the understanding of photoelectricity in prospective teachers, with increased engagement during learning activities. Inquiry-based methods such as POE have been shown to support effective learning. Researchers (Chen et al., 2020)emphasized that POE improves inquiry behavior and promotes science learning in the context of game-based learning. Meanwhile, Hidayati et al. (2024) emphasized that the POE model improves students' scientific thinking skills through predicting, observing, and explaining phenomena, as well as overcoming misconceptions in physics learning effectively.

Research (Hong et al., 2017b; Kibirige et al., 2014) in another study, it explores inquiry-based learning using the POE model through the WhyWhy application. They found that interest in learning had a positive effect on scientific thinking skills, while cognitive anxiety had a negative impact. Differentiated learning with the POE model can lower cognitive load and anxiety, thus supporting the development of scientific thinking skills.

The synthesis of these various studies shows that differentiated learning using the POE model has a significant positive impact on the development of students' scientific thinking skills. This model encourages active participation, increases cognitive engagement, and facilitates a deeper understanding of concepts. The success of this approach lies in its ability to incorporate prediction, observation, and explanation in the learning process, thus allowing students to develop critical thinking and scientific inquiry skills. However, it should be noted that the effectiveness of differentiated learning with the POE model also depends on factors such as students' interest in learning, self-confidence, and cognitive anxiety levels.

### Challenges and implementation of POE model differentiated learning

Based on the 10 final articles, it was found that the challenges and implementation of differentiated learning POE (Predict-Observe-Explain) models are as follows, for example, research from (Hong et al., 2017b)found that differentiation in inquiry models can complicate learning activities, although POE models are able to stimulate curiosity related to specific problems. Research from (Fatimah et al., 2023)emphasized that the POE model requires active student participation and engagement, with teachers having to facilitate effectively rather than dominate the learning process. But (Ayvacı, 2013b)note that misconceptions can arise during the explanatory stage, and group discussions can lead to conflicting hypotheses.

Research from (Chen et al., 2020)revealed that POE can pose a high cognitive burden for students, with mixed results in its implementation. Research from Hong et al. (2019) in another study noted variations in students' experiences with software applications, suggesting the exploration of collaborative learning with POE models in the future. (Banawi et al., 2019) emphasized the importance of teachers' understanding of the POE model for effective implementation, with the need for appropriate learning models in primary education. Research from also (N. Hidayati & Yonata, 2019) highlighting that the POE model requires thorough preparation for effective implementation, with teachers having to optimize learning activities within the time constraints available. (Latifah et al., 2019)identified that educators may have difficulty implementing POE effectively, and misconceptions may persist despite using POE strategies. Hong et al. (2019) in another study found that the POE model can increase cognitive anxiety in students, with extrinsic cognitive load can arise from a variety of factors.

In addition, research from (Karamustafaoğlu & Mamlok-Naaman, 2015b) highlights that the POE model may require extensive teacher training, students may have difficulty predicting outcomes accurately, and assessment methods should be aligned with the POE strategy. They also noted that group dynamics can affect student participation.

Thus, the synthesis of these studies shows that the implementation of differentiated learning of the POE model faces several main challenges. First, the need for thorough teacher preparation and training to understand and apply the model effectively. Second, the need to manage students' cognitive load and overcome misconceptions that may arise. Third, the importance of adapting the approach to various learning styles and abilities of students. Finally, the need to balance the active participation of students with effective facilitation from teachers, while overcoming time and resource constraints. Nonetheless, the POE model remains promising in enhancing active, inquiry-based science learning, with the potential to stimulate students' curiosity and critical thinking if applied appropriately and with appropriate differentiation.

## Discussion

This study aims to analyze the POE model in improving the understanding of science concepts and scientific thinking skills of elementary school students based on existing literature. This shows that differentiated learning with the POE (Predict-Observe-Explain) model shows significant effectiveness in improving students' understanding of science concepts and scientific thinking skills. These findings are consistent at various levels of education, from elementary school to college.

**Increased Understanding of Science Concepts:** The POE model has proven to be effective in improving students' understanding of science concepts. (Hong et al., 2017b)found that this approach encourages student-centered learning through self-exploration, which contributes to a deeper understanding of science concepts. These findings are supported by (Chen et al., 2020) who reported that students who used POE showed better performance in understanding physics concepts compared to traditional methods.

**The application of the POE model is also effective in overcoming misconceptions**. Research from (Ayvacı, 2013b) found that most of the misconceptions in prospective science teachers can be eliminated after using the POE method. This is reinforced by the findings of Latifah et al. (2019) which demonstrate the effectiveness of POE strategies in remediating misconceptions about temperature and heat. This success may be due to the structure of the POE that allows students to compare their predictions with the results of observations, thus encouraging a more accurate reconstruction of understanding.

**Development of Scientific Thinking Skills**: This model implements the differentiated learning POE model also has a positive impact on the development of students' scientific thinking skills. (Hong et al., 2021)reported a significant improvement in students' critical thinking skills through the use of the POE model. This model encourages students to engage in the process of prediction, observation, and explanation, which is an essential component of the scientific method. An example of (N. Hidayati & Yonata, 2019)emphasized that the POE model improves students' scientific thinking skills through activities of predicting, observing, and explaining phenomena. This process not only improves conceptual understanding, but also develops students' ability to think systematically and critically about natural phenomena.

Although effective, the implementation of differentiated learning of the POE model faces several challenges. (Hong et al., 2021) revealed that POE can pose a high cognitive burden for students, which can affect learning effectiveness. This shows the need for special attention in designing POE activities to suit students' cognitive capacity.

Research from (Latifah et al., 2019) identify that educators may have difficulty implementing POE effectively. This highlights the importance of adequate teacher training to ensure successful implementation. Research from (Karamustafaoğlu & Mamlok-Naaman, 2015b)also notes that the POE model may require extensive teacher training and assessment methods aligned with the POE strategy. These findings have important implications for science learning practices. First, the integration of the POE model in the science curriculum can improve students' conceptual understanding and scientific thinking skills. Second, continuous professional development is needed for teachers to ensure effective implementation. Third, the design of POE activities needs to consider the cognitive load of students to optimize learning.

For future research, it is recommended to further explore how collaborative learning can be integrated with the POE model, as suggested by (Hong et al., 2017a). In addition, longitudinal research is needed to assess the long-term impact of POE model differentiated learning on students' academic achievement and interest in science.

## CONCLUSION

Based on the systematic literature review conducted, the study reveals that differentiated learning with the POE (Predict-Observe-Explain) model effectively improves students' understanding of science concepts and scientific thinking skills across various educational levels. The model's effectiveness in promoting student-centered learning and addressing misconceptions underscores its value in science education reform, despite implementation challenges. These findings have important implications for science education practice, suggesting the need for structured teacher training programs and institutional support systems to facilitate successful implementation of the POE model. Moving forward, it is recommended that educational institutions invest in comprehensive professional development programs focusing on practical POE implementation strategies, including methods for differentiating instruction and developing appropriate assessment tools, while establishing collaborative support networks among teachers to ensure sustainable improvement in science education outcomes.

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