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Effectiveness of Innovative Learning Models to Improve Scientific Reasoning on Physics Topics: A Literature Review

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Abstract: Students' scientific reasoning ability in physics learning remains a significant challenge. This study aims to evaluate the effectiveness of innovative learning models in improving students' scientific reasoning based on indicators such as control, correlation, probability, deductive hypothesis, and conservation. The method used is systematic literature review with PRISMA framework. The results showed that innovative learning models, such as Problem-Based Learning, Project-Based Learning, and Inquiry-Based Learning, have a positive impact on students' scientific reasoning. However, each model has weaknesses in improving certain indicators, especially probability and deductive hypothesis. Therefore, this study recommends the development of a learning model that integrates an authentic problem-based approach with STEAM and cognitive conflict strategies to improve students' scientific reasoning. This research provides insights for educators and researchers in designing more effective and relevant learning strategies.

Keywords: Innovative learning models; Physics; Scientific reasoning

Introduction

Physics is the basic science for engineering and technology, making physics important to learn in schools (Assem et al., 2023). Physics is considered difficult by students compared to other subjects (Haryadi et al., 2021). Physics teaches students about experiential learning, so students are asked to observe and experiment as well as solve problems and find solutions (Assem et al., 2023; Price et al., 2019; Thohir et al., 2024). Physics is not only about mathematics but also understanding and applying concepts in everyday life. In previous studies, students still lacked a complete understanding of the concept so that they could not connect one concept with another (Huda et al., 2022). Students who experience concept difficulties have low concept mastery, according to Herayanti et al. (2022) research, students still have not mastered the concepts given before the stimulus in the form of phenomena.

Scientific reasoning skills are very important for students because they can improve students' abilities, especially in physics material (Pascaeka et al., 2023). Scientific reasoning itself is characterized by students having the ability to ask questions, make hypotheses, conduct experiments, and draw conclusions (Kamaluddin et al., 2023). Scientific reasoning enables students to understand natural phenomena, analyze data, and make rational evidence-based decisions (Abate et al., 2020; Aziz et al., 2023; Muchoyimah et al., 2019). This proves that scientific reasoning ability has a very important role in helping students to have a deeper understanding of scientific concepts (Kamaluddin et al., 2023). Some studies state that students' scientific reasoning skills are still relatively low, especially the indicator of controlling variables (Lorensia et al., 2024) and proportional (Atqiya et al., 2021).

Several innovative learning models have been implemented to improve students' scientific reasoning skills, such as the guided-inquiry learning model

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(Pascaeka et al., 2023), pjbl-stem (Bakri et al., 2023; Koes-H et al., 2021; Lorensia et al., 2024), problem based learning (Ningrum et al., 2024), ADI-stem (Atqiya et al., 2021), and others that are used on physics topics. These innovative learning models help students to explore concepts through experiments, group discussions and real-world problem solving (Ridwan, 2022). Since physics is closely related to natural phenomena and technology, it provides a great opportunity for the implementation of innovative learning models. Along with the development of innovative learning approaches, various strategies have been developed to improve students' scientific reasoning. Therefore, to find out new strategies that have the potential to improve scientific reasoning, a review through literature study on the effect of innovative learning models on scientific reasoning on physics topics is needed.

Method

This study uses the systematic literature review (SLR) method with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework guide. This method was chosen to provide a systematic and structured analysis of relevant literature. The data presented are research results on innovative learning models on scientific reasoning on physics topics. The studies reviewed were publications within the last 5 years, focused on students at the high school or college level, and involved innovative learning models on scientific reasoning.

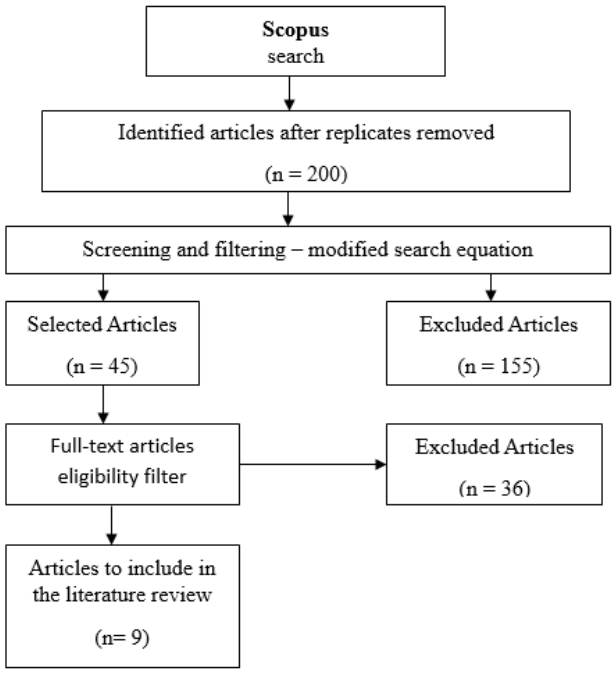

Figure 1. Systematic literature review methodology PRISMA flow diagram

Result and Discussion

Based on the search results regarding articles on innovative learning models in improving scientific reasoning on physics topics that have been published in the last 5 years can be seen in table 1.

Table 1. Articles on Innovative Learning Models for Scientific Reasoning on the topic of Physics in the Last 5 Years

Author	Innovative Learning Models	Physics topic	Research result
(Pascaeka et al., 2023)	Guided inquiry with vee map	Temperature and heat	In this study, the result was 87.91 in the experimental class.
(Koes-H et al., 2021)	Pjbl-STEM	Fluid	In this study, the average result was 77.92
(Lorensia et al., 2024)	Pjbl-STEM	Dynamic Fluid	In this study, the results obtained on the probabilistic reasoning indicator were 44% and the hypothesis-deductive reasoning indicator was 43% with a very good category.
(Syarqiy et al., 2023)	Phenomenon Based - ADI	Newton's law	In this study, the n-gain value was 0.46.
(Ningrum et al., 2024)	Problem Based Learning	Static Fluid	In this study, the average result was 82.8
(Atqiya et al., 2021)	ADI - STEM	Newton's law	In this study, the average result on the correlation indicator was 89.47, probabilistic was 53.63, proportional was 32.70.
(Viyanti et al., 2023)	PjBL - worksheet	Renewable Energy	In this study, the n-gain value was 0.72.
(Ayuni et al., 2022)	LKPD based PjBL-STEM	Renewable Energy	In this study, the result was 73.7 in the experimental class.
(Mochsif et al., 2021)	ADI – STEM - EFA	Temperature and heat	In this study, the n-gain value was 0.34

The results of the study show that innovative learning models have a positive impact on students' scientific reasoning skills. This is in accordance with research Ridwan (2022) which states that innovative learning models are able to help students explore concepts through experiments, group discussions, and real problem solving. Based on several previous studies, results based on scientific reasoning indicators such as

proportional, controlling, probabilistic, correlational, hypothesis-deductive, and conservation (Ayuni et al., 2022; Ningrum et al., 2024). In research Ayuni et al. (2022) and Ningrum et al. (2024) measured 5 indicators of scientific reasoning namely proportional, controlling, probabilistic, correlational, hypothesis-deductive, and conservation. In the study Ningrum et al. (2024) stated that further research was needed on probabilistic and hypothesis-deductive because in his research the two indicators were still low, especially in the hypothesis-deductive indicator. Meanwhile, in research Ayuni et al. (2022) the indicator that is still low is the controlling, correlational, and hypothesis deductive indicator.

However, the study Pascaeka et al. (2023) only measured three indicators of scientific reasoning, namely control, correlation and conservation, in which the correlation indicator received the lowest score compared to the other two indicators. This is because students still cannot determine the relationship between variables (Pascaeka et al., 2023). In research Atqiya et al. (2021) also measured 3 indicators of scientific reasoning, namely proportional, probabilistic, and correlation, where the results showed that proportional and probability indicators were still low compared to other indicators. This is because students' self-confidence and feelings when learning are another factor in the low probability reasoning of students (Atqiya et al., 2021).

Based on the research results of the study of innovative learning models used, it can be concluded that there are innovative learning models that are able to improve students' scientific reasoning abilities, but there are still indicators that are still low obtained with different models. Previous research also only measured some indicators of scientific reasoning so that it could not find out whether the innovative learning model was able to improve students' scientific reasoning skills as a whole. Therefore, an innovative learning model is needed that implements authentic problems, determines between one concept and another and designs solutions in the form of miniature technology. In this case, the learning that can be used is authentic problem-based learning integrated with STEAM and cognitive conflict strategy.

Conclusion

The results show that innovative learning models have a positive impact on students' scientific reasoning skills. However, not all innovative learning models are able to improve all scientific reasoning indicators equally. Some indicators, such as probability and deductive hypothesis, often show lower results than others. Therefore, it is necessary to develop innovative learning models that can integrate authentic problems, relationships between concepts, and technology-based solutions. An authentic problem-based learning approach integrated with STEAM and cognitive conflict strategies is an alternative that can be used.

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