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Literature Review: Effectiveness of Causal Learning Model in Improving Problem-Solving Ability

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ABSTRACT

The development of innovative learning models in the last decade demands a systematic evaluation of their effectiveness and implementation trends. This article presents a systematic literature review of 500 indexed publications (2016-2025) to analyze the development, impact, and research trends of causal learning models in improving learners' problem-solving skills, particularly in science learning. The analysis revealed a significant increase in publications related to this model, with a growth of 25% per year, although fluctuations occurred in certain periods. The dominance of research is in the form of journal articles (62 publications) with a primary focus on physics, with the *Journal of Physics and Technology Education* being the most productive source (17 articles, 122 citations). Empirical evidence is strong that the causal model, especially when combined with *scaffolding*, is effective in improving problem-solving skills (the top article received 36 citations). Conceptual mapping through VOSviewer showed close links between the model and critical thinking skills, conceptual understanding, and science learning. These findings strengthen the position of the causalytic model as a relevant learning strategy to address the challenges of 21st-century education, while highlighting the need for further research related to implementation across disciplines and educational contexts.

INTRODUCTION

Changes and developments in all aspects of life are taking place at a rapid pace. There is no clear clue as to how people will learn in the future and what needs to be learned to meet future needs. As we already know that science and technology in the 21st century are developing very quickly, affecting all aspects of life, especially in the world of education (Mahrunnisya, 2023). The implementation of active learning is one of the strategies adopted by the government in responding to the dynamics of globalization and answering the challenges of 21st-century competencies (Stehle & Peters-Burton, 2019; Van Laar et al., 2020; Larson & Miller, 2011; González- Pérez & Ramírez-Montoya, 2022). This development poses new challenges for the education system in Indonesia. The current curriculum focuses on learning that emphasizes the stages of the scientific process (Meltzer, 2002). One of the solutions to these challenges is to provide students with certain skills. The abilities that students must have to be able to face the challenges of the 21st century are: the ability to think critically and creatively, the ability to communicate effectively, the ability to innovate, the ability to solve problems, and the ability to collaborate (Mashudi, 2021).

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The evolving 21st-century learning encourages the evolution of learning models, including in Science and Technology (SCT), which is often considered difficult. Therefore, the causal model was developed to explain the concepts of a material to students more effectively. According to Sari et al., (2020), Causal thinking consists of two elements, namely causal and analytic thinking. Causality refers to the relationship between the cause element and the effect element. On the other hand, analytics is defined as the process of analyzing the conditions of each causal element, then evaluating the possible consequences that can occur based on the combination of these conditions. Causality means that in the learning process, students are facilitated to be able to analyze each problem into elements of causes and effects that are likely to occur. According to Rokhmat (in Abdani et al., 2018), this approach has five advantages, including training in the analysis of scientific phenomena, a holistic understanding of concepts, and the ability to think critically, divergently, and solutively based on scientific concepts.

The accelerated development of innovative learning models in the last decade calls for systematic efforts to evaluate their effectiveness and development trends. One model that has shown a significant increase in educational research is the causal learning model, particularly in the context of science and technology. However, to date, no literature review comprehensively maps the development, implementation, and impact of this model in the period 2016-2025. This kind of review is crucial to identify patterns of success, challenges, and opportunities for the development of causalytic models in the future. This literature review aims to analyze the development of causalytic model research from 2016 to 2025, evaluate the consistency of empirical findings related to its impact on learning outcomes, and identify research gaps for future development.

METHODS

This study uses a descriptive and analytical approach with the aim of understanding and mapping research trends related to the effectiveness of causal learning models in improving students' problem-solving skills. Data were collected through searching scientific articles from the *Dimensions* and *Google Scholar* databases for the last ten years, from 2016 to 2025, using relevant keywords such as *causal learning model*, *problem solving*, and science *learning*. To support the analysis process and visualize the relationship between research topics, VOSviewer software was used. In total, 500 relevant documents indexed within this timeframe were analyzed to identify patterns, trends, and interrelationships of topics related to the implementation of causal learning models in the context of science education. Google Scholar was chosen as the source of document searches because it uses consistent selection standards in indexing documents and provides a larger number of documents compared to other major databases, especially in the field of educational research (Hallinger & Chatpinyakoop, 2019; Hallinger & Nguyen, 2020; Zawacki-Richter et al.).

RESULTS AND DISCUSSION

This study aims to describe research trends that focus on the application of causal learning models in improving learners' problem-solving skills. The scientific articles analyzed include publications from 2016 to 2025 that are relevant to the topic. Figure 1 below presents a visualization of research trends related to the use of causal learning models in the context of developing problem-solving skills in the educational environment.

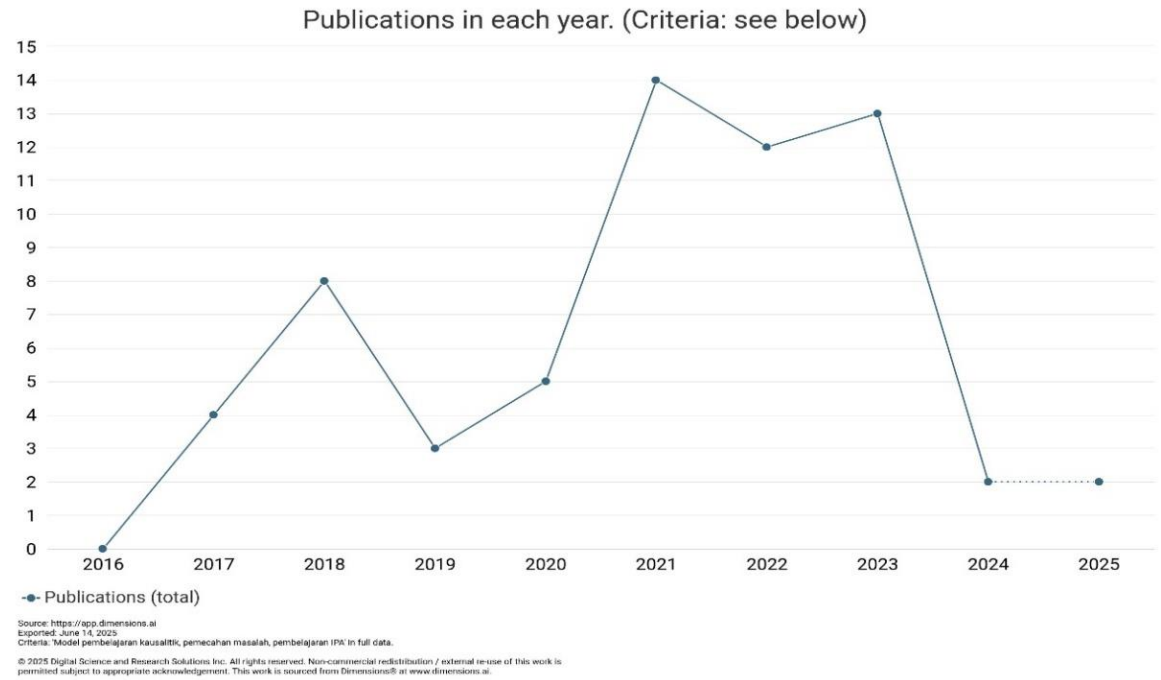

Figure 1. Research trend of the Causalytic model to improve problem-solving ability.

Based on the publication trend graph from 2016 to 2025 that discusses the causal learning model to improve students' problem-solving skills in the education system, it appears that the number of studies conducted has fluctuated throughout the period. In 2016, there were no publications related to this topic. The trend began in 2017 with the emergence of 4 publications, then increased in 2018 to 8 publications. However, in 2019, there was a decrease in the number of publications to 3. The trend again showed a significant increase in 2021, with a total of 14 publications. However, in 2024, the number of publications decreased dramatically to only 2 publications. This finding indicates that although interest in the causal learning model has grown in certain periods, it has not shown a stable consistency in the realm of Education research. This research trend provides a deeper insight into the effectiveness of the causal learning model in improving students' problem-solving skills. In addition, this study also maps the various categories of publications that address the causal learning model in the context of developing problem-solving skills, as shown in Table 1, according to the category and focus of each study.

Table 1. Publication Category of Causalytic Model to Improve Problem-Solving Ability.

Publication Category	Number of Publications
Article	62
Proceeding	1

The table above presents data on research trends on causal learning models to improve students' problem-solving skills based on publication categories. From the table, it can be seen that the majority of publications fall into the category of scientific articles. As many as 62 publications are articles published in national and international scientific journals. Meanwhile, only 1 publication came from the proceedings of a scientific seminar or conference. This finding shows that the discussion of causal learning models is more widely studied in the form of journal articles than in seminar forums. Furthermore, the researcher presents fifteen (15) journal names that consistently publish research related to the causal learning model to improve students' problem-solving skills. These journals are frequently referenced sources on similar topics and are the main references in the development of causal learning model studies. Further information on the journal names and the number of published articles is presented in Table 2.

Table 2. Trends in journal source titles of causal learning models to improve learners' problem-solving skills 2016-2025.

Journal Name	Publications	Excerpt	Average Quotation
Jurnal Pendidikan fisika dan teknologi	17	122	7.18
Jurnal of Physics Conference Series	7	33	4.71
Jurnal penelitian Pendidikan IPA	5	33	6.60
Jurnal Ilmiah Profesi Pendidikan	5	4	0.80
ORBITA Jurnal Pendidikan dan Ilmu fisika	5	1	2.20
Jurnal Pijar MIPA	3	24	8.00
Jurnal Pendidikan fisika Indonesia	2	8	4.00
International journal of education methodology	1	13	13.00
Jurnal pendidikan fisika	1	0	-
Prosiding SNFA (Seminar nasional fisika dan aplikasinya)	1	7	7.00

Based on the analysis of journals that published research on causal learning models in improving students' problem-solving skills, it was found that there were 10 main journals referenced in this study. Table 2 shows the distribution of the number of publications, citations, and average citations in each journal. The Journal of Physics Education and Technology ranks first with the highest number of publications, totaling 17 articles and 122 citations, with an average of 7.18 citations per article. Followed by the Journal of Physics Conference Series, which has 7 publications with a total of 33 citations. Although the number of publications is smaller, Pilar MIPA Journal recorded the highest average citation, which is 8.00 per article from 3 publications. Other journals that are also quite active in publishing articles related to this topic include the Journal of Science Education Research, Scientific Journal of Education Profession, and ORBITA Journal. Interestingly, although the International Journal of Education Methodology only has one publication, the article received 13 citations with an average of 13.00 citations, indicating a fairly high scientific impact. Meanwhile, several other journals such as Indonesian Journal of Physics Education, Journal of Physics Education, and SNFA Proceedings also contributed to the dissemination of causal model research, albeit with lower numbers of publications and citations. Overall, these findings show that the topic of causal learning models has received attention from various education journals, both national and international, although the distribution has not been even.

Based on the number of publications on causal learning models to improve problem-solving skills, the researchers also identified the titles of articles that are often referred to by researchers. The title of the article can be seen in Table 3.

Table 3. Top citations on the causal model to improve learners' problem-solving skills.

Excerpt	Year	Author	Title
36	2017	Faridatul Helmi, Joni Rokhmat, Jannatin ‘Ardhuha	Pengaruh Pendekatan Berpikir Kausalitik Ber-Scaffolding Tipe 2b Termodifikasi Berbantuan Lks Terhadap Kemampuan Pemecahan Masalah Fluida Dinamis Siswa.
35	2022	Jenny Capriconia1, Fatni Mufit	Analysis of Concept Understanding and Students' Attitudes towards Learning Physics in Material of Straight Motion.
20	2020	J Rokhmat and N, N, S Verawati	The causalitic learning model to increase students’ problem-solving ability.
16	2020	Yulyatna Sari, Joni Rokhmat, Hikmawati	Pengaruh Model Pembelajaran Kausalitik Terhadap Kemampuan Pemecahan Masalah Fisika Peseta Didik.
12	2017	Ina Yuliana, Joni Rokhmat2, I Wayan Gunada	Pengaruh Berpikir Kausalitik Ber-Scaffolding Terhadap Kemampuan Pemecahan-Masalah Kalor pada Siswa SMA.

The researcher also identified the most frequently referenced articles in the study of the causal learning model. This identification aims to determine the extent of an article's contribution to the development of research related to improving problem-solving skills through a causal approach. The five articles with the highest citations during the analysis period are shown in Table 3. The article with the highest number of citations of 36 citations, was written by Fachrudi, Helmi, and Joni Rokhmat (2017), which discusses "the effect of the 2B-type scaffolding causal thinking approach assisted by LKS on students' dynamic fluid problem solving skills". This article shows that the combination of the causalytic approach and scaffolding strategy can have a significant impact on improving students' ability to solve physics problems. In second place, there is an article by Jenny Capriconita and Fasti Wulfi (2022), which received 35 citations. This research analyzes students' concept understanding and attitudes towards physics learning with straight motion material, and shows that the causal model can significantly improve students' understanding. Furthermore, the article by J. Rokhmat, Marzuki, Kosim, and N. S. Verawati (2020) received 20 citations. This article discusses the application of the *causalistic learning model* in improving students' problem-solving skills and makes important contributions to the development of instruments and implementation of the model. Problem solving and critical thinking are important 21st-century skills to be trained (Afandi, 2019; Doleck et al., 2017). Both require systems thinking to make it easier for students to connect the cause and effect of a phenomenon, learn how components interact as a series of interactions, and improve their understanding of various subjects, including science (Hmelo-Silver, 2007; Ke L et al., 2021).

The other two articles are by Yuwita, Sari, and Joni Rokhmat (2020) with 16 citations, and Ina Yuliana, Joni Rokhmat, and I Wayan Suadnya (2017) with 12 citations. The citations of this article strengthen the evidence of the effectiveness of the causal learning model in supporting students' problem-solving in various physics learning contexts. Article citations that discuss the causal learning model to improve students' problem-solving skills in the period from 2016 to 2025 are in line with the publication trend, which fluctuates. This suggests that the topic receives consistent attention from researchers and is actively referenced in the development of future studies.

Next, a visualization of the results of data analysis using VOSviewer software on 500 articles indexed in Google Scholar is presented. This visualization shows the relationship between interrelated subjects in scientific studies on causal learning models and improving problem-solving skills. The keyword linkages and the occurrence of dominant topics in the articles are visualized in Figure 2 below.

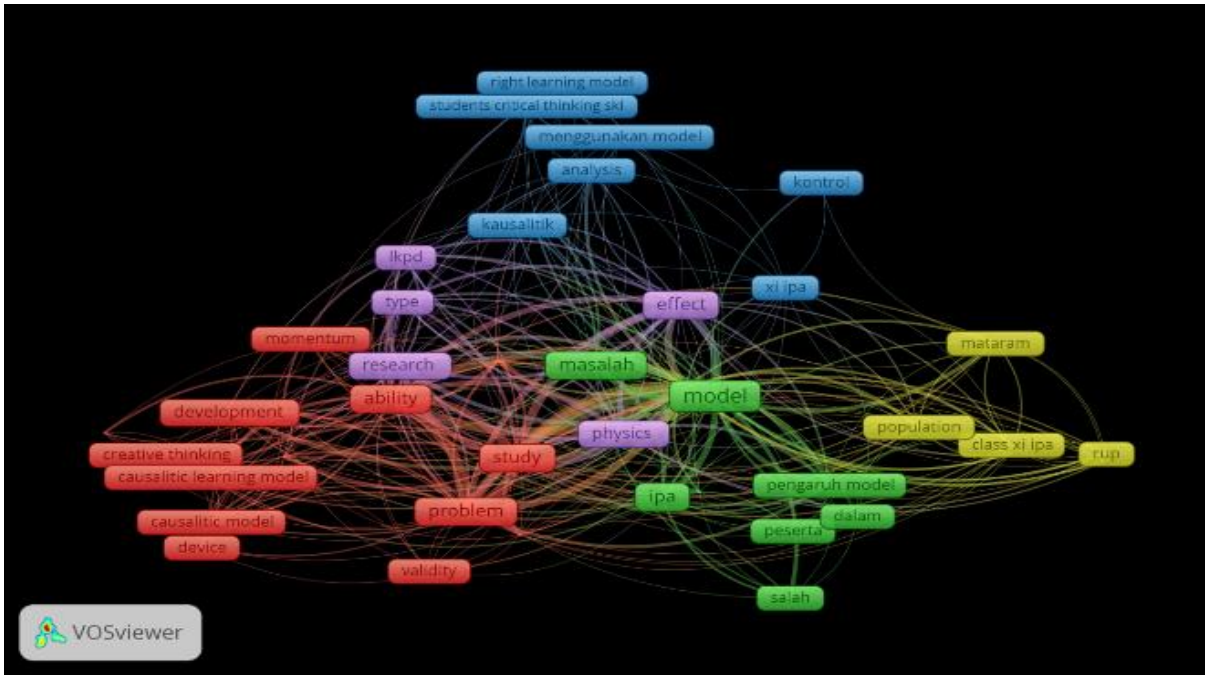

Figure 2. Visualization of the results of mapping word relationships on research trends related to the causal learning model.

In Figure 2, 43 keyword items are frequently used in research on causal learning models from 2016 to 2025. In addition, Figure 2 also contains 5 clusters, where the first cluster is red, which consists of 15 items with the keyword ability. Causalistic learning model, causalistic model, science, development, and others. The second cluster is green, which consists of 8 keyword items, including science, learning models, model influence, and others. The third cluster is blue, which consists of 8 keyword items, including analysis, causalistic, right learning model, and others. The fourth cluster is yellow, which consists of 7 items with keywords including conceptual understanding, population students, and others. Finally, the fifth cluster is purple with 5 keyword items including effect, lkpd, physics, research, and type. Below is also presented Figure 3 based on *overlay* visualization.

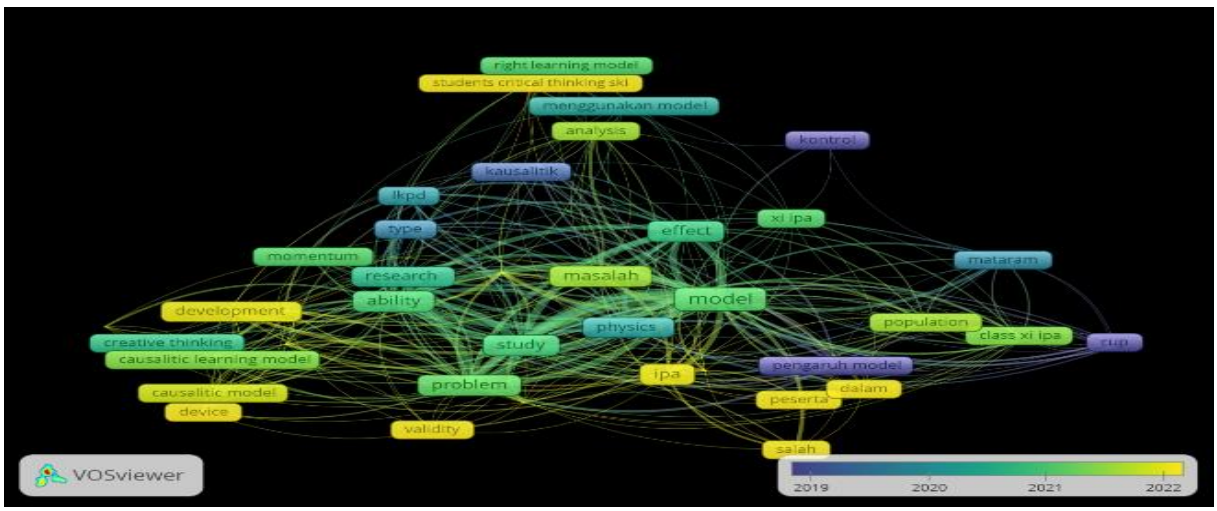

Figure 3. Visualisasi *overlay* model pembelajaran kausalitik untuk meningkatkan kemampuan pemecahan masalah.

Figure 3 shows the trend of keywords related to causal learning models to improve students' problem-solving skills indexed by Google Scholar from 2016 to 2025. The dimmer the color intensity in the visualization indicates that the topic has a low frequency of research or has received less attention in previous studies (Kaur et al., 2022; Liao et al., 2018). Trent's research with *overlay* visualization shows the novelty of the research trend of causal learning models to improve students' problem-solving skills. It can be seen from the overlay visualization image in 2019 that purple shows old research until 2020 is also still a little purple. until the color gets lighter in 2022, which is yellow, showing the latest research.

The research trend regarding the causal learning model to improve students' problem-solving ability can be seen in Figure 4 visualization of the research density of the causal learning model below.

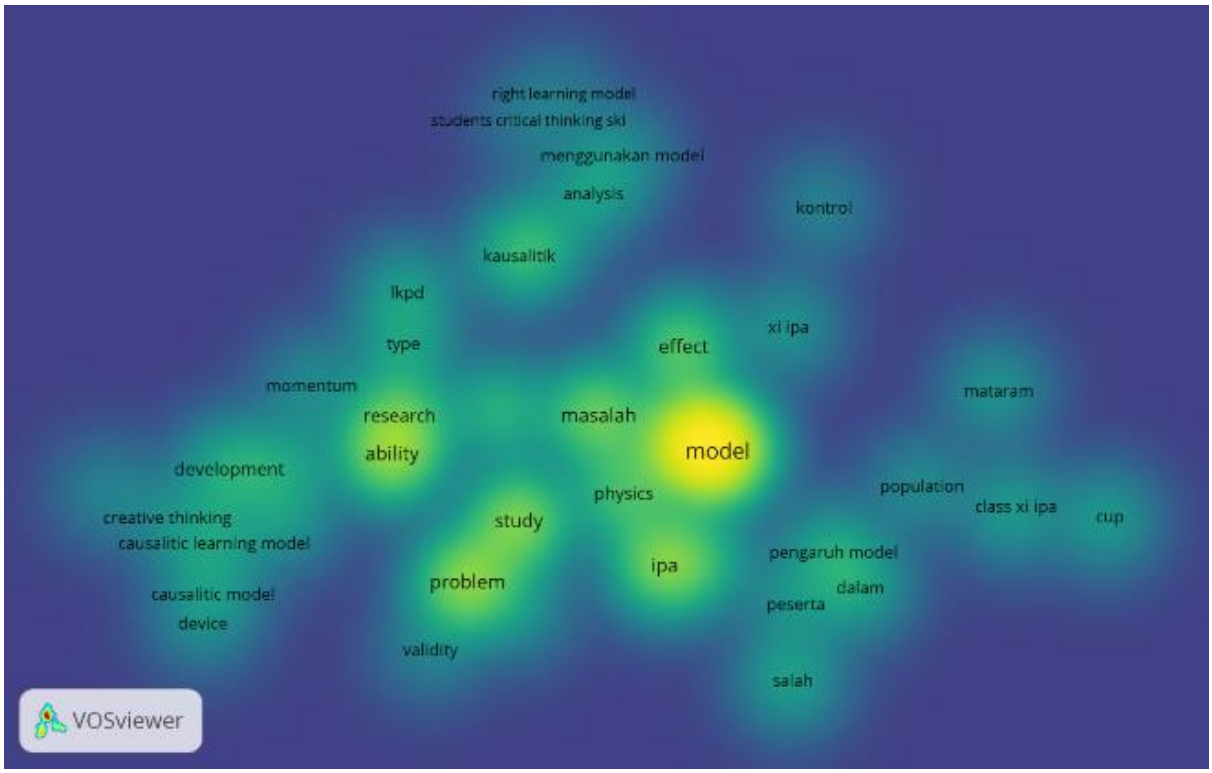

Figure 4. Visualization of density in causal learning model research to improve learners' problem-solving ability.

Figure 4 shows the visualization of keyword density analyzed using VOSviewer software based on 500 articles indexed in Google Scholar. The bright yellow color indicates areas with the highest intensity or frequency of keyword use, while blue areas indicate lower intensity (Bahtiar, et al. 2023). This visualization illustrates the intensity of occurrence and interconnectedness of concepts in research on causal learning models and improving students' problem-solving skills. The keywords with bright yellow color, such as "model", "problem", and "ability", show the highest frequency of occurrence and become the center of attention in this research map. These words are closely related to other keywords such as "physics", "IPA", and "study", which confirms that the context of applying the causalytic model is most dominantly found in science learning, especially physics. In addition, the appearance of terms such as "causalistic learning model", "creative thinking", and "device" on the left side shows that there is attention to the development of learning tools based on causalistic models that support higher-order thinking skills. Keywords such as "effect", "development", and "research" also indicate

that many studies are exploring the impact and effectiveness of this model in various approaches.

Overall, the trend of research on causal learning models in improving students' problem-solving skills shows an increasing trend. This is indicated by the high number of citations in various publications on the topic. This finding indicates that the causal learning model has strong relevance and great potential to be applied in an effort to improve learners' problem-solving skills, especially in science learning.

CONCLUSION AND SUGGESTION

Based on the results of the literature review of publications during the period 2016 to 2025, it can be concluded that research on causal learning models shows an increasing trend, both in terms of the number of publications, citations, and the scope of topics studied. Although there are fluctuations in the number of publications each year, researchers' attention to the effectiveness of this model is maintained and even strengthened in certain years. Most of the research is published in the form of journal articles, which indicates that the causal learning model has become the focus of serious scientific studies and contributes to the development of learning practices, especially in science learning. The journals that were the dominant source of publication showed high citation rates, indicating the recognition and relevance of previous research findings. In addition, the articles with the highest citations reinforce the evidence that the causal approach, especially when combined with other methods such as scaffolding, has a significant impact on improving learners' problem-solving skills. Visualization of the data using VOSviewer also shows close relationships between dominant concepts and keywords, such as ability, conceptual understanding, causalitic model, and physics, which supports the application of this model in science learning more broadly. Thus, the causalitic learning model has great potential and high relevance to be applied as a learning strategy that can develop higher-order thinking skills, especially in the context of students' problem solving.

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AUTHOR CONTRIBUTIONS

All authors made significant contributions to the writing and completion of the submitted journal manuscript.

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