Research Trends on Guided Inquiry Models to Improve Students' Critical Thinking Skills in Science Learning: A Bibliometric Analysis

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Abstract: This research explores the influence of guided inquiry through bibliometric analysis using the Publish or Perish, VOSviewer, and Dimensions tools. Utilising overlay, density, and network visualisations, this study identified key research trends, relationships between concepts, and frequency density of terms in the literature related to guide inquiry. The results of the analysis showed that publications related to guided inquiry on improving critical thinking skills have increased, with articles and Proceedings being the most dominant forms of publications. These findings suggest that guided inquiry not only supports more flexible science learning, but also to improve students' critical thinking skills in various subject areas.

Keywords: Bibliometric analysis; Critical thinking; Guided inquiry

Introduction

Everyone needs education as a basic need, and it is also the first step towards the formation of human beings who are expected to develop in various sectors in order to be able to compete and answer problems in this century, namely the 21st era. Science learning is one of the fields of knowledge where 21st century skills are becoming increasingly important. Of course, the most important aspect of learning science is understanding the meaning of abstract ideas. The purpose of studying science is to develop conceptual understanding, scientific ability, and critical thinking skills. Of course, to understand them, it is necessary to use more complex ways of thinking than just conventional thinking (Musliman et al., 2022). One way to think about and understand science ideas or concepts is by using critical thinking skills.

Critical thinking ability is a way of thinking that is always curious about existing information to achieve a deep understanding (Farida et al., 2017; Oktaviarini et al., 2018). Critical thinking allows students to solve problems encountered in learning so that they can describe in a structured manner including reviewing existing information (Lusiana et al., 2021). Critical thinking in students is a habit that can be trained by promoting the role of education in a more effective concept (Cahyaningsih et al., 2019). The condition of students being able to think critically helps students achieve understanding in concepts and is bridged by the learning process at school. In line with social studies material that helps learners to become reflective citizens (Sanusi et al., 2023). So that in science learning requires a learning process that is able to facilitate students to develop their critical thinking skills, according to their respective educational levels.

Various learning models are needed to apply the concept of creative thinking of students in undergoing student learning (Oktaviarini et al., 2018). Due to the interesting learning process, each student can experience a variety of feelings and emotions, such as excitement, enthusiasm, difficulty, challenge, boredom, laziness, frustration, satisfaction, achievement, and others (Lu et al., 2022). When encountering these conditions, teachers

need to vary more innovative learning models, which allow for the triggering of critical thinking in their students. One of the learning models that has the hope of developing students' practice sessions in critical thinking skills is the guided inquiry model (Ahaddin et al., 2020). Guided inquiry learning motivates students to find and analyse answers to problems (Dewi et al., 2020). Meanwhile, finding and analysing answers to problems is a critical thinking and reflection skill (Akinoglu et al., 2015). Student activities involved in guided inquiry learning include making observations, asking questions and analysing, testing and evaluating hypotheses, proving and interpreting experimentally, providing simple explanations and discussions, providing further explanations and arguments, predicting and presenting results, and discussing (Dolman, 2016). Improving critical thinking skills by using the incuri learning model was successfully proven at SDI Babussalam Sangkawana (Sanusi et al., 2023). The increase in critical thinking skills can be observed when starting planning activities, group discussions to test work that occurs in cycle II which results in the activeness of students in the teaching and learning process. Other research that discusses the effectiveness of guided inquiry learning models on critical thinking skills in science learning is proven by the significant difference between classes that provide guided and independent learning opportunities and classes that, compared to classes that do not use guided and independent learning opportunities, have higher average scores (Widiya et al., 2023). Guided inquiry combined with flipbook media also shows an increase in critical thinking skills by comparing student results between pre and post tests after guided inquiry learning treatment (Wahyuni et al., 2023). The focus in guided inquiry is seen in each step/syntax of guided inquiry itself, and there are activities that are key during assessment planning, namely (1) providing basic explanations, (2) building basic information-seeking skills, (3) constructing conclusions, (4) providing further explanation, (5) using strategies and techniques when solving problems.

The relationship between critical thinking skills and guided inquiry learning models is often juxtaposed in existing studies. The process in guided inquiry learning helps learners structurally solve problems and provide effective solutions (Abdulla, 2023). Studies that intersect with the use of guided inquiry learning models that emerge, there are still few that analyse the use of bibliometric analysis in the development of periodicals that link the guided inquiry learning model with students' critical thinking skills in science learning.

Bibliometric analysis is an effective method to identify and evaluate research trends in a particular field. This tool allows data to be analysed systematically and relevant information to be extracted, allowing researchers to gain a holistic picture of the current situation in their field of expertise (Hutami et al., 2023). Bibliometric analysis is a statistical tool used to map the state of scientific knowledge, help identify important information needed for research purposes, opportunities, and strengthen scientific research or publications (Machmud et al., 2023). Bibliometric analysis can be summarised as a systematic search to find an overview of trends that have the opportunity to find developmentally appropriate research.

This research study discusses research trends related to guided inquiry learning models that affect critical thinking skills in science learning on the google scholar database using bibliometric analysis methods. With regard to the purpose of this study is to find out the publication trends related to research on the effect of guided inquiry learning on science critical thinking skills from the google scholar database based on the year of publication. Based on the description and analysis that will be discussed, find out some interesting facts that affect the availability of journal publications with certain topics and a certain period of time, and related to the guided inquiry learning model.

Method

For the purpose of transforming available data into easily understood and useful information, the method used is a library review using a bibliometric analysis approach. Bibliometric analysis research methods are generally used to provide a comprehensive understanding of research trends, progress, and scientific sources used in answering research questions (Hakim, 2020). This research focuses on bibliometric analysis in the field of science learning with the keywords used "inquiry learning" and "critical thinking skills". This study examines the trends or evolution of research domains related to topics, as well as authors within a discipline. Bibliometric analysis, also known as scientometrics, is a research evaluation methodology. This analysis can be carried out using specific methods found in the literature (Ellegaard et al., 2015). The use of eligibility criteria for the research articles reviewed include: 1) obtained from information sources indexed by Google Scholar published in the range of 2015-2024 using analytical tools such as Publish or Perish and Dimension.ai. 2) related to guided inquiry and critical thinking skills. 3) to filter data that has been collected through Publish or Perish, researchers use the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guide. While the exclusion criteria in this study are proceedings and books related to the main topic. In this study, the bibliometric analysis method uses several stages (Chen et al., 2016).

After data collection, bibliometric analysis and content analysis were used to identify research trends, key topics, and gaps in learning models to improve students' critical thinking skills. Bibliometric analysis was conducted with the help of software such as VOSviewer to visualise the relationship between keywords frequently used in research, in showing the growing trends and areas that need to be further explored. This analysis aims to provide a comprehensive picture of the effectiveness of the new model of classroom learning, innovations, and challenges in developing critical thinking skills using this approach.

Result and Discussion

In accordance with the findings of the search conducted using Publish or Perish on Google Scholar, it indicates that the development of research on the influence of the guided inquiry model with critical thinking skills in science subjects in the period between 2015 and 2024 has experienced a stable number. It can be seen that the addition or reduction in the number of articles is not too significant. This shows that the guided inquiry learning model is still an interesting learning model and is not replaced by other learning models to optimise students' critical thinking skills.

Research Trends

Figure 1 shows that the trend of research on critical thinking skills in science learning from 2015 to 2024 has been significant each year. In 2015, the number of research publications related to guided inquiry models and critical thinking skills in science learning was still at a relatively low number, recording only about 78 publications. In 2016, the number of publications increased to 135, followed by an upward trend that continued in 2017 (190 publications), 2018 (325 publications), and 2019 (495 publications). The peak number of publications was reached in 2021, with 1,567 publications. This indicates that during this period, the topic received widespread attention among academics and educational practitioners.
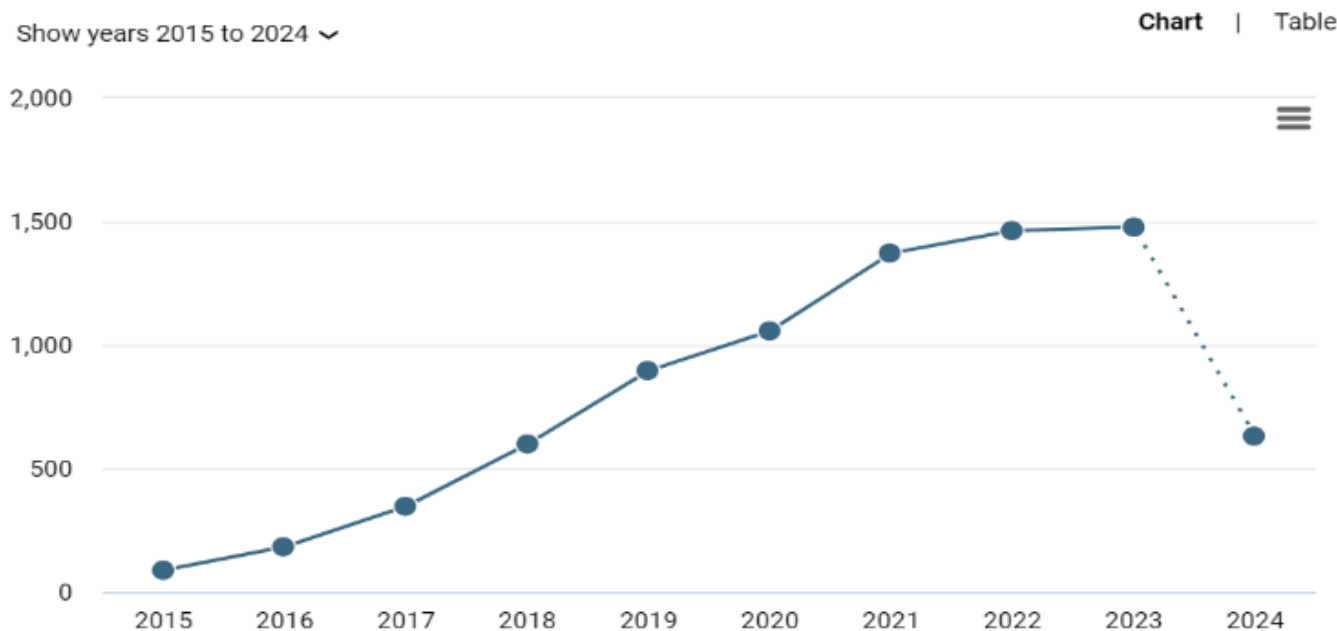
Figure 1. Research trends on guided inquiry learning model to improve students' critical thinking ability

In 2015, the number of publications was still at a relatively low level, indicating that at the beginning of the period, this topic was not yet a major focus in science education research. However, the graph shows a significant upward trend from year to year during the 2015-2021 period. This indicates the increasing interest and attention from researchers to the use of guided inquiry models and their potential in developing students' critical thinking skills.

The peak number of publications was reached in 2021, signaling that during that period, this topic received wide attention among academics and educational practitioners. This high research interest could be due to the growing awareness of the importance of critical thinking skills as an essential competency that students should have, especially in facing the challenges of the 21st century.

The graph begins to show a slowing of the increase in 2022, and even a decline in the number of publications in 2023 and 2024. This trend could indicate several possibilities, such as the emergence of new research topics that interest researchers, a shift in focus in

educational research priorities, or even saturation in studying the same topic continuously.

Network Visualization

Figure 2 shows the results of bibliometric keyword mapping of research trends on guided inquiry models to improve critical thinking skills. This diagram illustrates the pattern of relationships and interrelationships between key concepts related to the use of guided inquiry learning models to improve students' critical thinking skills. At the centre of the diagram is the core concept of "inquiry model" which is closely linked to various other aspects. From here spread the various relationships and influences that can be observed.
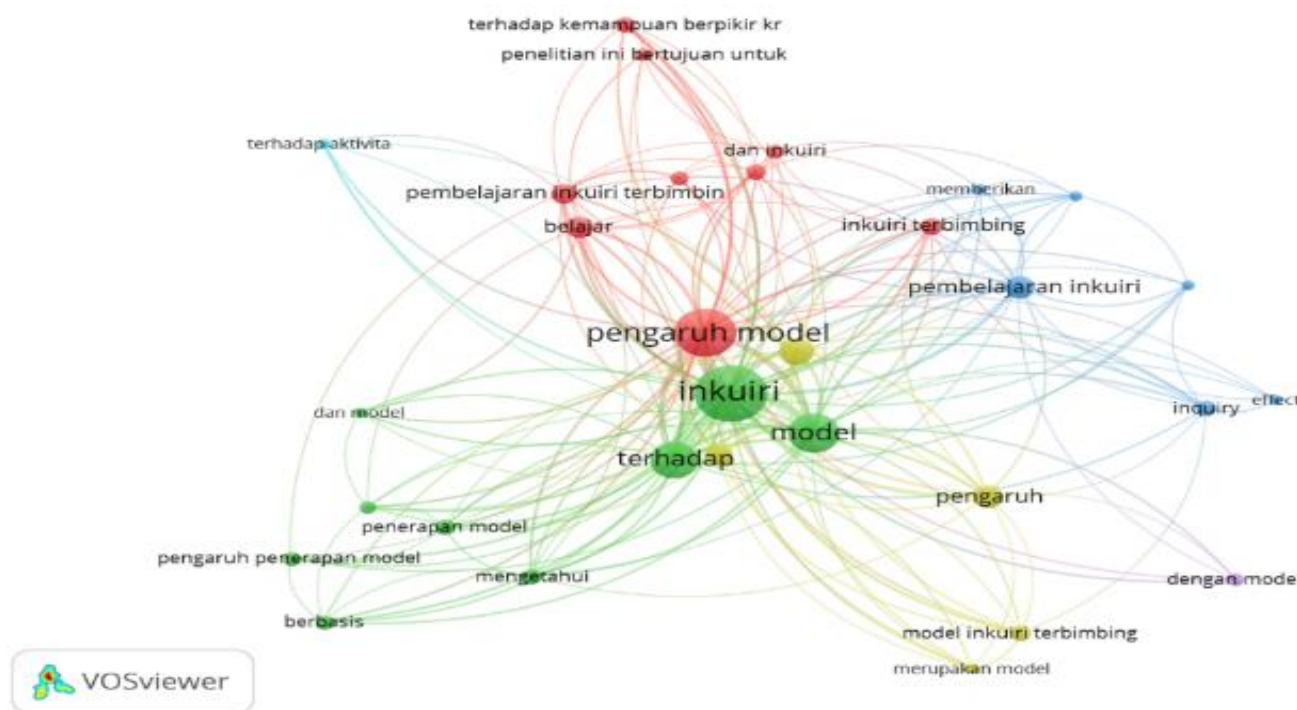
Figure 2. Network visualization in guided inquiry learning model to improve students' critical thinking skills

For example, "guided inquiry learning" has a direct link to "inquiry model", indicating that the guided inquiry model is one type of inquiry learning model that is applied. Meanwhile, "the effect of the model" and "on critical thinking skills" have connecting lines, indicating that the use of the guided inquiry model has an effect on improving students' critical thinking skills. In addition, there are other concepts such as "inquiry effect", "model application", and "research" that are also related to the inquiry model, either directly or indirectly. This shows that research topics on guided inquiry models cover a wide range of aspects, from the impact, application, to the research methodology used.

Overall, this diagram illustrates the complexity and interconnectedness between the various elements that are the focus of the research on the use of guided inquiry learning models to improve students' critical thinking skills. This visualization can help identify key themes and relationships between concepts in this area of research.

Visualization of Over

Figure 3 shows the trend of keywords related to research on guided inquiry learning models to improve critical thinking skills in journals indexed by Google Scholar from 2016 to 2019.

At the centre of the diagram is the core concept of "inquiry model" which is the main focus. From this concept, several linkages can be seen that explain the dynamics of research in this topic. For example, "guided inquiry learning" is directly connected to "inquiry model", indicating that guided inquiry learning is one form of application of a broader inquiry model. Furthermore, the relationship between "the effect of the model" and "on critical thinking skills" indicates that the use of the guided inquiry learning model has a positive effect on improving students' critical thinking skills. This is in line with the main objectives of research in this field.

In addition, other concepts such as "inquiry effect", "model implementation", and "research" are also related to "inquiry model", either directly or indirectly. This demonstrates the complexity of research studies on guided inquiry models, covering aspects ranging from impact to implementation to research methodology. The bottom graph adds a temporal dimension, illustrating the trend of research publications on this topic from 2016 to 2019. This information provides an overview of the development and increased attention to research on

guided inquiry learning models and students' critical thinking skills during this period.

Overall, this diagram provides a comprehensive visualisation of the conceptual structure and relationships between various key elements in research related to the application of guided inquiry models to improve students' critical thinking skills. This information can help identify key themes, trends and interconnections between concepts in this dynamic field of research.
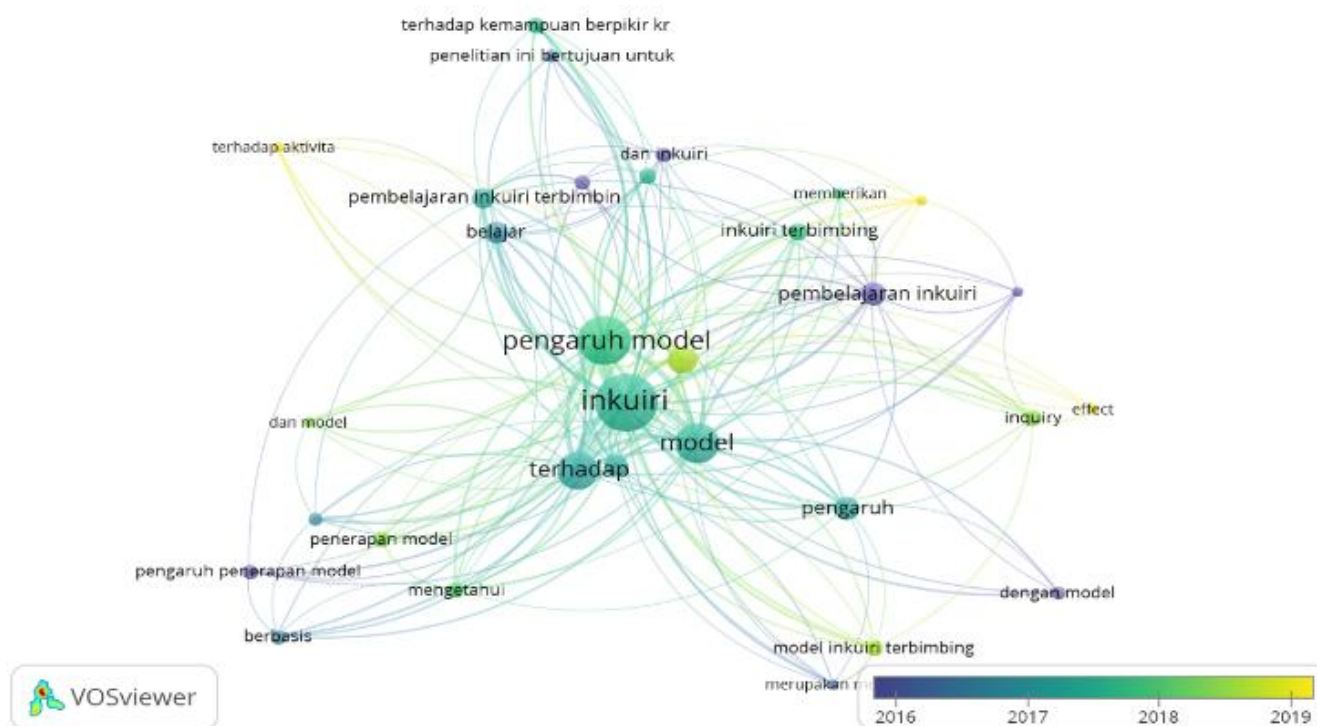
Figure 3. Visualisation of overlay on guided inquiry learning model to improve students' critical thinking

Density Visualisation

Figure 4 shows the complex conceptual relationships between various elements related to the use of guided inquiry learning models to improve students' critical thinking skills. In the centre of the diagram, the core concept of "inquiry model" is the main focus. From here, various branches and interrelated relationships can be seen. For example, "guided inquiry learning" is directly linked to "inquiry model", indicating that guided inquiry learning is one form of application of the broader inquiry model.

Furthermore, there is a relationship between "the effect of the model" and "on critical thinking skills", which indicates that the application of the guided inquiry learning model has a positive effect on improving students' critical thinking skills. This is in line with the objectives of the studies in this topic. In addition, other concepts such as "inquiry effect", "model implementation", and "research" are also related to "inquiry model", either directly or indirectly. This shows the complexity and diversity of aspects studied in research on guided inquiry models, including impact, implementation, and research methodology.

This visualisation provides a comprehensive overview of the conceptual structure and relationships between various key elements in the research related to the application of guided inquiry learning models to improve students' critical thinking skills. This information can help identify key themes, trends and interconnections between concepts in this dynamic field of research. The results of a previous study entitled "Bibliographic Analysis: Research Trends on the Effect of Problem-Based Learning Models on Critical Thinking Skills in Science Learning" showed that the dominant keywords related to critical thinking skills in science learning were "the impact of science, problem-based learning, elementary school, and the effect of learning models" (Hutami et al., 2023).

The research has similar keywords in the data search, namely "critical thinking" which can support this research. There were differences in the results of this study with existing research. This is because there are differences in the keywords needed in data searches, namely different learning models and in this study using the latest article sources in the past 10 years, namely 2015 to 2024.

This Dimensions graph not only reflects short-term interest during the pandemic but also shows an increased awareness of the importance of digital literacy in education.

Publication Type

Based on Table 1, it is known that research on guided inquiry models to improve critical thinking skills in science learning from 2015 to 2024 is contained in 5 types of publications. Based on the type of publication, articles are the most dominant form of paper, with a total of 7,850 publications.

Table 1. Trends in Guided Inquiry Model for Critical Thinking Skills of Research Students Based on Publication Type

Publication Type	Publication
Article	7,850
Proceeding	230
Chapter	61
Edited Book	38
Preprint	17
Monograph	4

In addition to articles, there are also other types of publications, such as proceedings with 230 publications, chapters in books totalling 61 publications, edited books totalling 38 publications, as well as preprints and monographs with 17 and 4 publications respectively. This shows the diversity of publication channels utilised by researchers in disseminating findings related to the use of guided inquiry models and their effects on improving students' critical thinking skills.

The dominance of publications in the form of articles indicates that this topic has received wide attention from academics and science education practitioners. In addition, the number of publications in the form of proceedings is also quite significant, indicating that there are efforts to present and discuss the results of related research in scientific forums. Overall, this data provides a comprehensive picture of the trends and variety of publications that are developing in the field of research that examines the application of guided inquiry models to improve students' critical thinking skills. In assessing the quality of a scientific work, one method that can be used is by counting the number of times the work is stated by other researchers (Herawati et al., 2022).

Source Title

The figure and table show that research related to guided inquiry models to improve critical thinking skills has grown significantly. 10 leading journals that contain research publications on trends in guided inquiry learning models to improve students' critical thinking skills during the period 2015-2024 can be seen. The Journal of Science Education Research tops the list with 410 publications and an average citation count of 2.91 per article. This shows that the journal is a major channel for researchers to publish their research on this topic.

Table 2. Top 10 Source Title Trends of Guided Inquiry Learning Model to Improve Students' Critical Thinking Skills Research in 2015-2024

Name	Publications	Citations	Citations Mean
Jurnal Penelitian Pendidikan IPA	410	1,192	2.91
Journal Of Physics Conference Series	211	949	4.50
Advances In Social Science, Education and Humanities Research	164	250	1.52
Jurnal Pijar Mipa	139	566	4.07
Jurnal Basicedu	102	543	5.32
Jurnal Pendidikan Fisika Dan Teknologi	89	504	5.66
Edukatif Jurnal Ilmu Pendidikan	85	232	2.73
Jurnal Ilmiah Profesi Pendidikan	82	119	1.45
Jurnal Pendidikan Teori Penelitian Dan Pengembangan	80	241	3.01
Berkala Ilmiah Pendidikan Fisika	73	227	3.11

Journal of Physics Conference Series ranks second with 211 publications and a fairly high average number of citations of 4.50 per article. This indicates that this journal is also a publication target of interest to researchers. This is followed by Advances In Social Science, Education And Humanities Research in third place with 164 publications and an average citation of 1.52 per article. Other journals such as Pijar Mipa Journal, Basicedu Journal, Journal of Physics and Technology Education, and several other journals also show significant publication and citation numbers.

Overall, this table provides a comprehensive overview of the landscape of research publications related to guided inquiry models and their influence on students' critical thinking skills in the context of science learning in Indonesia during the period 2015-2024.

Conclusion

Based on the bibliometric analysis conducted, research on the application of guided inquiry models to enhance students' critical thinking skills in science learning has developed significantly over the period 2015–2024. The keywords used in data searches influence the research results, with this study utilizing the latest article sources from the past ten years. Articles are the most dominant form of publication, followed by proceedings, book chapters, edited books, preprints, and

monographs, demonstrating the diversity of publication channels used for disseminating research findings. Furthermore, this topic has gained wide attention among academics and science education practitioners, as evidenced by the various leading journals frequently cited in this study. Overall, this research provides in-depth insights into the trends and dynamics of applying guided inquiry models to improve students' critical thinking skills while highlighting the importance of using the latest sources in science education research.

Author Contributions
The author greatly contributed to the creation of this article, starting from the initial stages of research until the completion of this article.

Conflicts of Interest
No conflict interest.

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