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Guided Inquiry in Science Education: A Bibliometric and Systematic Review of Critical Thinking and Science Literacy Research

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abstract

The guided inquiry model represents an increasingly prominent pedagogical approach in science education, demonstrating substantial potential to foster critical thinking skills and science literacy through structured investigative processes. This study aims to map research trends in the application of Guided Inquiry over a ten-year period (2016–2026), identify emerging research innovations, and delineate prospective directions for future scholarly development in this domain. Data were systematically retrieved from the Scopus database in February 2026, yielding an initial corpus of 609 articles. A rigorous selection process was subsequently conducted in accordance with the PRISMA framework, applying predefined inclusion and exclusion criteria, which resulted in 154 articles eligible for final analysis. A bibliometric approach was employed in conjunction with a systematic literature review, utilizing VOSviewer and Microsoft Excel 2021 as analytical tools. The findings reveal a consistent upward trajectory in annual publication output, with a notable peak recorded in 2025, alongside the identification of seven distinct, interconnected keyword clusters. The most frequently occurring keywords encompass guided inquiry, inquiry-based learning, critical thinking, and scientific literacy. overlay and density visualizations further indicate that these thematic areas remain dynamically evolving, while their integration with complementary pedagogical approaches constitutes a salient gap warranting further investigation in the context of science education. Future research is recommended to prioritize longitudinal and experimental studies examining the sustained impact of guided inquiry on critical thinking and science literacy, explore its integration with emerging digital technologies such as artificial intelligence and virtual reality, and conduct cross-cultural comparative investigations to broaden the generalizability of current findings across diverse educational contexts and systems.

1. Introduction

Critical thinking skills and science literacy are essential competencies in science learning, but various studies show that both skills are still relatively low in students (Mulyani et al., 2022). This low achievement indicates that the learning applied is not fully able to develop the ability to analyze, evaluate, and make decisions based on scientific evidence. Various studies have examined the application of learning models, including Guided Inquiry, to improve these skills (Muhtadin & Sudibyo, 2022; Muhtadin et al., 2023). However, studies that comprehensively map research development, especially related to trends, focuses, and innovation potentials in the application of Guided Inquiry to critical thinking skills and science literacy, are still limited. Therefore, a bibliometric analysis is needed that is able to provide a comprehensive picture of the direction of research development and identify future research opportunities.

Recent research shows that although critical thinking skills are a major focus in science education, their implementation still faces various obstacles in the field. Study by Kirk et al. (2023) affirms that the development and monitoring of critical thinking skills in science-based learning Guided inquiry is still a challenge for teachers. In addition, research Aras et al. (2024) shows that students' low critical thinking skills are still the main problem influenced by the dominance of conventional teacher-centered learning. These findings are reinforced by Sapriati et al. (2024) which states that students' involvement in limited scientific activities has an impact on the low analytical and evaluation skills in science learning. Furthermore, Kunnath & Botes (2025) emphasized that although the inquiry-based approach is developing, its implementation is still not optimal in integrating critical thinking skills systematically in the classroom. Therefore, a more comprehensive effort is needed to assess the effectiveness and development of research related to the application of learning models that are able to overcome these problems.

In recent years, the number of publications on Guided inquiry, critical thinking skills, and science literacy show a significant upward trend, with the peak of the surge occurring in 2025. This increase is in line with recent research findings showing that the Inquiry Become a major focus in the development of science literacy and critical thinking skills in modern science education (Mujriati et al., 2025). In addition, the increasing demands on mastering 21st century skills, especially critical thinking skills and science literacy, have also encouraged the intensification of research in this field, in line with the need to deal with the complexity of global problems and rapid technological developments (Kirk et al., 2023).

On the other hand, the post-pandemic learning transformation has also contributed to the increased attention to inquiry-based learning models that are adaptive to digital and contextual learning. Recent studies have shown that the integration of technology, such as augmented reality and digital-based learning, in a Guided inquiry able to significantly improve students' engagement and critical thinking skills (Mukaromah & Fibriana, 2024). In addition, a systematic study of inquiry-based learning confirms that this approach is increasingly adopted in various educational contexts in response to the need for learning innovation in the digital era. This condition has led to increased attention from researchers to the effectiveness of the model Guided inquiry in developing critical thinking skills and science literacy, thus having an impact on the surge in the number of publications by 2025 (Alarcón et al., 2023).

In line with these problems, critical thinking skills are fundamental competencies that students need to possess because they play an important role in managing information, analyzing data, and drawing logical and evidence-based conclusions (Mashudi, 2021). Individuals who have critical thinking skills are able to identify problems, gather relevant information, evaluate data, and make rational and open decisions (Paul, R., & Elder, 2008). Therefore, this skill is an important provision

for students in facing the dynamics of global change Nugraha et al. (2017), as well as contributing to the development of science literacy.

In addition to critical thinking skills, science literacy is also an important competency in 21st-century learning. Science literacy refers to the ability to access, understand, and apply scientific concepts in daily life, including in problem-solving and evidence-based decision-making (Mashudi, 2021; Zulaika et al., 2022). These competencies include critical thinking, communication, collaboration, and creativity skills (Banila et al., 2021), as well as providing a systematic foundation in understanding natural phenomena and technology (Hartono et al., 2023). Therefore, science learning needs to be designed in an integrated manner to develop both competencies simultaneously. One approach that can accommodate these needs is the learning model Guided Inquiry. This model emphasizes the process of scientific investigation with the guidance of the teacher, so that students still have direction in finding concepts independently. Through this approach, students are trained to think analytically, process data, and draw conclusions based on the results of the investigation.

A number of studies show that the learning model Guided inquiry effective in improving students' science literacy. According to Zulaika et al. (2022) Through the Guided Inquiry model, students are trained to find concepts directly through learning experiences, so that science literacy indicators can be achieved. These findings are strengthened by Aprizanti (2023) which affirms that Guided inquiry is one of the effective models in improving science literacy skills. This effectiveness is due to the characteristics of learning that emphasize on a process of inquiry based on science principles, where students follow procedures that they do themselves with the formulation of problems determined by the teacher (Heather & Randi, 2008). Through this process, students are trained to think creatively and analytically, find and find solutions to problems independently, and work together in collecting and processing data to draw conclusions. This activity encourages the formation of a deeper understanding (Jannah et al., 2024). In addition, the interaction between teachers and students in learning Guided inquiry It also contributes positively to the improvement of science literacy, even becoming one of the strongest predictors in its achievement (Kang, 2022).

Furthermore, the guided inquiry model not only has an impact on science literacy, but is also able to develop various 21st-century skills. Research shows that this model can improve students' critical and creative thinking, communication, collaboration, and self-evaluation skills (Gormally et al., 2009; Yaumie et al., 2025). In its implementation, teachers play the role of facilitators who guide students in the process of investigation to solve problems independently (Scott, 2018). The investigation process is in line with contextual learning that emphasizes solving real problems, so that it has the potential to increase science literacy more optimally.

Although bibliometric studies on inquiry-based learning, critical thinking skills, and science literacy have grown rapidly in recent years, they still show a number of fundamental limitations. Some bibliometric studies tend to focus on specific aspects separately, such as science literacy or critical thinking skills, without examining the relationship between the two integratively in the context of science learning. In addition, studies that raise the inquiry approach are generally still general and have not specifically examined the Guided Inquiry model as an approach that has the characteristics of structured guidance in the scientific inquiry process. In fact, recent bibliometric studies related to Guided Inquiry focus more on certain aspects, such as scientific attitudes, without linking them to critical thinking skills and science literacy simultaneously

Furthermore, most of the previous research was still limited to mapping publication trends, author productivity, and keyword emergence using tools such as VOSviewer, without exploring the conceptual relationships between topics or identifying the direction of research development in

depth. In fact, recent research shows that the development of critical thinking skills in guided inquiry-based learning still faces implementation challenges in the field, especially in the aspect of monitoring and systematically integrating these skills in the learning process. This indicates that although research continues to develop, there is still a gap in understanding how critical thinking skills and science literacy are effectively integrated within the Guided Inquiry learning framework.

Based on these limitations, this study offers a more comprehensive approach by integrating bibliometric analysis of Guided Inquiry topics, critical thinking skills, and science literacy simultaneously in one study framework. In contrast to previous research that tended to be partial, this study not only maps publication trends, but also analyzes the linkages between research themes, identifies conceptual development patterns, and explores potential future research innovation directions. Thus, this study is expected to make a new contribution in clarifying the research landscape and filling analytical gaps that have not been widely revealed in previous bibliometric studies.

Based on the research gaps that have been identified, there are still limitations in bibliometric studies that comprehensively integrate the topics of Guided Inquiry, critical thinking skills, and science literacy, especially in revealing the conceptual linkages and directions of future research development. Therefore, this study aims to: (1) visualize research trends regarding Guided Inquiry in improving critical thinking skills and science literacy during the period 2016–2026; and (2) explore the potential for innovation and future research development directions through bibliometric analysis. The results of this research are expected to provide a comprehensive overview of research developments and become the basis for formulating more effective and evidence-based science learning development strategies.

2. Method

The method used in this study is a literature review (literature review) with a bibliometric approach. This review of the bibliometric literature analysis is based on explicit and systematic methods (Garza-Reyes, 2015). Data are obtained through secondary data sources obtained from the website of research archive provider Scopus (https://www.scopus.com). Bibliometric analysis is the process of analyzing publications using mathematical or statistical approaches to identify the distribution, patterns, and developments of research in a particular field of study, which can also illustrate its impact, where the operation involves searching for relationships between various unique keywords (Indriyanti et al., 2023; Musyarrafah & Muqarramah, 2021; Yani & Soebagyo, 2023). Bibliometric analysis visualizes the interconnectedness of research concepts, where the gaps found between these keywords can be used to innovate future studies (Astuti et al., 2023). Meanwhile, the literature review is the basis for expanding knowledge efforts to formulate new ideas based on existing findings, taking into account implications, limitations, suggestions, future research directions, and scientific progress (Perwitasari et al., 2023).

The bibliometric analysis in this study follows five stages developed by (Tranfield, 2003), i.e. keyword determination, keyword search, refinement of initial search results, compilation of statistical data, and data analysis (Indriyanti et al., 2023; Lestari et al., 2023). The data collection process was carried out using the PRISMA protocol (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to ensure transparency and replication of research. The PRISMA stages include identification, screening, feasibility, and inclusion. At the identification stage, searches are conducted using the following Scopus query strings: TITLE-ABS-KEY ("guided inquiry" OR "guided inquiry learning") AND ("critical thinking" OR "higher order thinking" OR "analytical thinking") AND ("scientific literacy" OR "science literacy"). The search is limited to

documents published in the period 2016–2026, with the inclusion criteria: (1) research articles (Research Articles), (2) written in English, and (3) relevant to the context of science education. Meanwhile, exclusion criteria include: (1) a literature review article or bibliometric study, (2) a document other than an article (e.g. Conference Papers, Book Chapters), and (3) articles that do not directly address the relationship between Guided Inquiry, critical thinking skills, and science literacy.

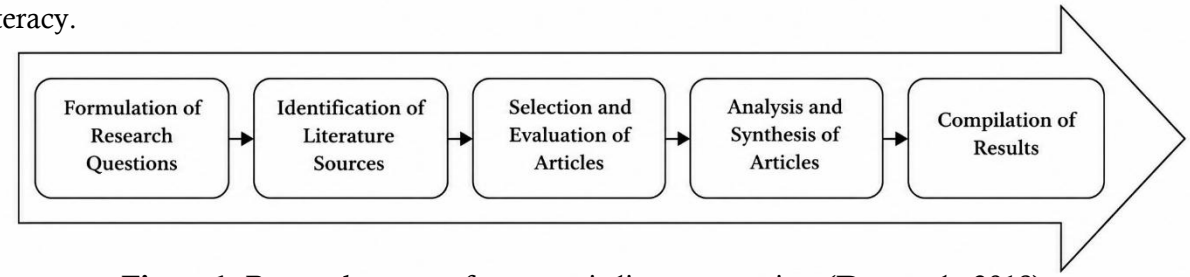

Figure 1. Research stages of systematic literature review (Day et al., 2018)

The initial database search yielded a total of 609 documents. During the screening stage, duplicate records were removed and articles were filtered based on an evaluation of titles and abstracts, resulting in the retention of 349 articles. Subsequently, at the eligibility assessment stage, a full-text review was conducted to verify the conceptual relevance and thematic alignment of each article with the focus of the present study. Articles deemed insufficiently relevant to the core research scope were systematically excluded, yielding a final corpus of 154 articles for bibliometric analysis. The selection process is systematically documented in accordance with the PRISMA framework, as illustrated in Figure 1 and the corresponding PRISMA diagram presented in Figure 2.

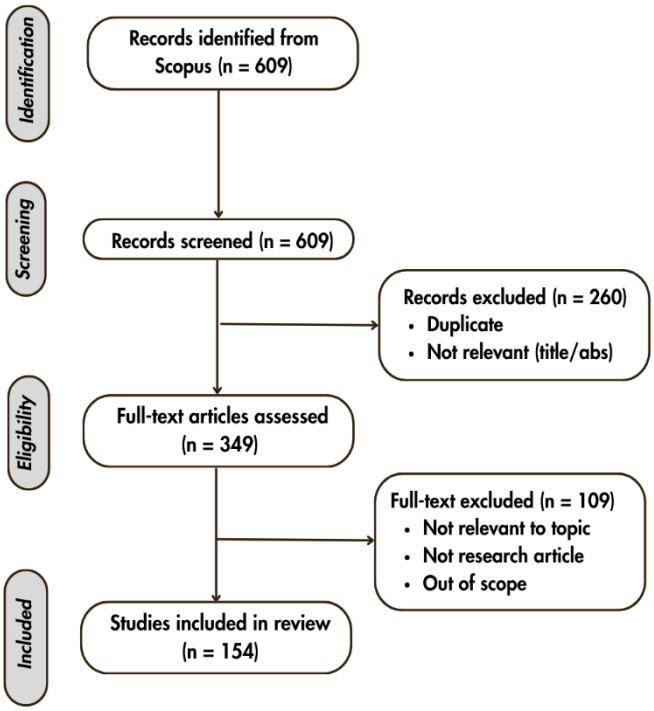

Figure 2. PRISMA diagram

Data that satisfied the selection criteria were subsequently exported in CSV format and analyzed using VOSviewer software to map keyword relationships, delineate research trends, and identify thematic clusters within the corpus. Microsoft Excel was additionally employed for the management and compilation of descriptive statistical data. Prior to analysis, a rigorous data cleaning process was undertaken to consolidate semantically equivalent terms — for instance, "science literacy" and "scientific literacy", as well as "guided inquiry" and "guided inquiry learning" — thereby enhancing the accuracy and consistency of bibliometric visualization outputs. The systematic literature review component of this study was conducted across five sequential stages, as comprehensively outlined in Figure 1.

3. Result and Discussion

Visualize research trends on the Guided Inquiry model in improving students' critical thinking skills and science literacy over 10 years (2016–2026)

Based on bibliometric analysis, 10 articles with the highest citations or frequently cited in other studies were identified. These 10 articles can be seen in Table 1. The articles with the highest citations are mostly from 2021 and 2023, with a relatively even distribution of publications in various journals in the field of science education. The article with the highest citations, "The effect or The Inquiry-Based Learning Approach on Student's Critical-Thinking Skills"Written by (Duran & Dökme, 2016). This article discusses the impact of the application of inquiry-based learning (Inquiry-Based Learning) on students' critical thinking skills in science learning. The study used an experimental design with an experimental group learning through guided inquiry and a control group with traditional methods in grade 6 students. The results showed that inquiry-based learning significantly improved students' critical thinking skills compared to conventional learning.

Table 1. 10 Articles with the highest citations

Author	Title	Journal	Index & SJR	Quotes
Duran & Dökme (2016)	The effect of the inquiry-based learning approach on student's critical-thinking skills	Eurasia Journal of Mathematics, Science and Technology Education	Scopus (Q2; SJR 0.693)	197
Wale & Bishaw (2020)	Effects of using inquiry-based learning on EFL students' critical thinking skills	Asian-Pacific Journal of Second and Foreign Language Education	Scopus (Q1; SJR 0.972)	111
Styers et al. (2018)	Active learning in flipped life science courses promotes development of critical thinking skills	CBE Life Sciences Education	Scopus (Q1; SJR 1.343)	111
Almulla & Al-Rahmi (2023)	Integrated Social Cognitive Theory with Learning Input Factors: The Effects of Problem-Solving Skills and Critical Thinking Skills on Learning Performance Sustainability	Sustainability (Switzerland)	Scopus (Q1; SJR 0.750)	96
Irwanto et al. (2018)	Promoting Critical Thinking and Problem Solving Skills of Preservice Elementary Teachers	International Journal of Instruction	Scopus (Q2; SJR 0.612)	68

	through Process-Oriented Guided-Inquiry Learning (POGIL)			
Romero-Ariza (2017)	Inquiry-based learning: Is there enough evidence of its benefits in science education?	Eureka Journal of Science Teaching and Dissemination	Scopus (Q3; SJR 0.322)	64
Doolittle et al. (2023)	Defining Active Learning: A Restricted Systematic Review	Teaching and Learning Inquiry	Scopus (Q1; SJR 0.760)	55
Sadaf et al. (2021)	Cognitive Presence in Online Learning: A Systematic Review of Empirical Research from 2000 to 201	Computers and Education Open	Scopus (Q1; SJR 2.903)	52
Chen (2021)	Fostering students' workplace communicative competence and collaborative mindset through an inquiry-based learning design	Education Sciences	Scopus (Q1; SJR 0.878)	51
Wen et al. (2023)	Integrating augmented reality into inquiry-based learning approach in primary science classrooms	Educational Technology Research and Development	Scopus (Q1; SJR 1.836)	49

Meanwhile, from Figure 3, it can be observed that the trend of the publication rate of articles regarding the guided inquiry model in improving students' critical thinking skills and science literacy over 10 years with the graph showing a consistent increase until the end of 2025, Research on this topic shows a high trend in 2025, with the number of publications reaching 47 articles in one year. In contrast, 2017 had the fewest articles, with only 1 article. The average level of publications discussing the guided inquiry model in improving students' critical thinking skills and science literacy over 10 years is 15 articles.

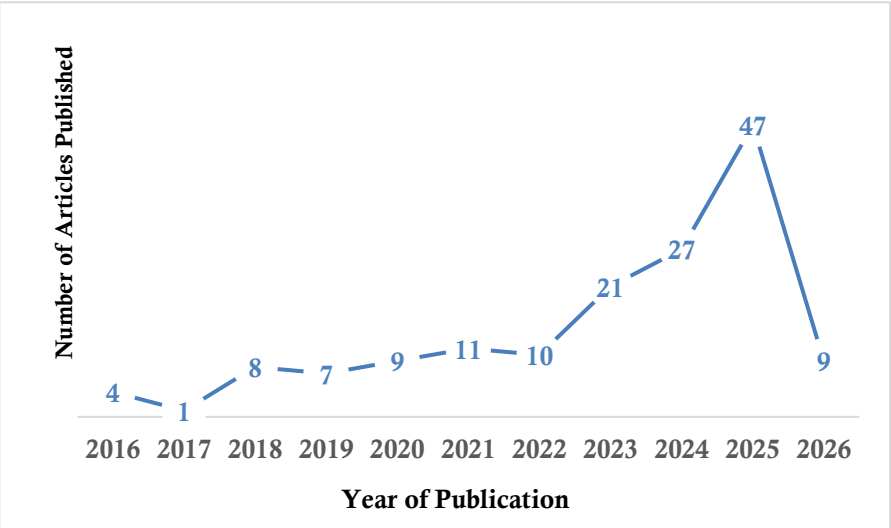

Figure 3. Development of article publications from 2016-2026

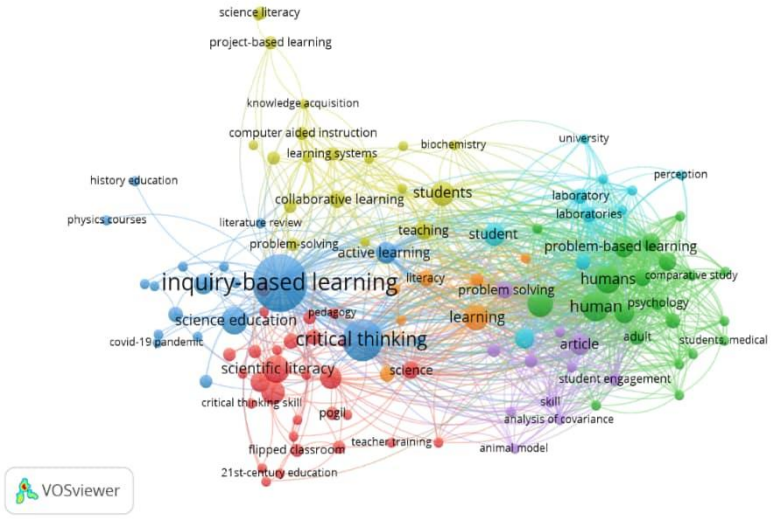

Figure 4. Publication keyword mapping

The analysis using VOSviewer resulted in a visualization of the keyword network as shown in Figure 4, which consists of 7 clusters with 1180 connections and a link strength of 1874. These results show that the research on Guided inquiry In improving critical thinking skills and science literacy, science has a strong topic linkage and develops multidimensionally. Each cluster represents a grouping of research themes based on conceptual proximity, where the size of the circle indicates the frequency of occurrence of keywords, while the connecting line describes the strength of the relationship between topics (Astuti et al., 2023; Indriyanti et al., 2023).

Conceptually, the seven clusters formed not only show a variety of research topics, but also reflect the direction of the development of studies in guided inquiry-based science education. Cluster 1 is shown by a red circle visualization consisting of 29 keywords, namely "21st-century education"; "argumentation"; "augmented reality"; "collaboration"; "creativity"; "critical thinking skill"; "critical thinking skills"; "digital literacy"; "ethnoscience"; "flipped classroom"; "guided inquiry"; "inquiry"; "inquiry based learning"; "inquiry learning"; "nature of science"; "pedagogy"; "physics learning"; "pisa"; "pogil"; "primary school"; "science"; "scientific literacy"; "self-efficacy"; "sustainable development goal"; "teacher professional development"; "teacher readiness"; "teacher training"; "teachers"; "teaching materials". In cluster 1, the most frequently mentioned keyword was "critical thinking skills", with a total of 9 events, 24 connections, and 27 link strengths. Cluster 1 (red), which is dominated by keywords such as critical thinking skills, scientific literacy, 21st-century education, and teacher professional development, indicates that the main focus of the research is on the development of 21st-century competencies. The dominance of the keywords critical thinking skills shows that these skills are the center of attention in the implementation of guided inquiry. This reinforces the view that inquiry-based learning is not only oriented towards mastering concepts, but also on developing high-level thinking skills. Implicitly, teachers need to design learning that focuses not only on content, but also on students' thinking processes through argumentation activities, collaboration, and scientific exploration.

Cluster 2 is shown by visualizing a green circle consisting of 21 keywords, including "academic performance"; "adult"; "artificial intelligence"; "clinical competence"; "comparative study";

"education"; "education"; "education, medical"; "educational measurement"; "female"; "human"; "humans"; "male"; "medical education"; "medical student"; "problem-based learning"; "problem-based learning"; "procedures"; "psychology"; "satisfaction"; "structural questionnaire"; "students medical". In cluster 2, the most frequently mentioned keywords are "humans", with a total of 12 incidents, 52 connections, and 146 link strengths. Cluster 2 (green) which is dominated by keywords such as medical education, problem-based learning, and clinical competence shows the expansion of the application of the inquiry approach to other fields outside school science education, especially in higher education and the health sector. The emergence of keywords such as humans and medical students indicates that inquiry approaches, including guided inquiry, are beginning to be adopted in the context of professional learning. This shows that the inquiry approach has high flexibility, but at the same time indicates that research in the school context still needs to be deepened specifically.

Cluster 3 is shown with a visualization of a dark blue circle consisting of 19 keywords, including "21st century skills;" "covid-19 pandemic"; "critical thinking"; "educational innovation"; "engagement"; "higher education"; "history education"; "inquiry-based learning"; "literature review"; "mathematics education"; "meta-analysis"; "online learning"; "physics courses"; "research trends"; "science education"; "socio-scientific issues"; "socioscientific issues"; "systematic review". In cluster 3, the most frequently mentioned keywords are "inquiry-based learning" with a total of 54 events, 84 connections, and 153 link strengths. Cluster 3 (dark blue) which contains keywords such as inquiry-based learning, science education, meta-analysis, and systematic review reflects the development of studies at the level of conceptual analysis and research synthesis. The high frequency of inquiry-based learning shows that this approach has become mainstream in educational research. However, the dominance of these general terms also indicates that studies that specifically highlight guided inquiry are still relatively limited. Implication, research that focuses more on the unique characteristics of guided inquiry is needed than other inquiry approaches.

Cluster 4 is shown by a yellow circle visualization consisting of 19 keywords, including "biochemistry"; "collaborative learning"; "computer aided instruction"; "computer-based learning"; "curricula"; "education computing"; "engineering education"; "geography education"; "invention-based learning"; "knowledge acquisition"; "learning models"; "learning systems"; "practical work"; "problem-solving"; "project-based learning"; "science literacy"; "stem education"; "students"; "teching". In cluster 4, the most frequently mentioned keywords are "students" with a total of 10 events, 52 connections, and 104 link strengths. Cluster 4 (yellow) which contains keywords such as science literacy, STEM education, problem-solving, and project-based learning shows the relationship between guided inquiry and other innovative learning approaches. This indicates that guided inquiry is often integrated with approaches such as STEM and project-based learning to improve problem-solving skills and science literacy. The implication is that the integration of various learning models has the potential to be an effective strategy in improving the quality of science learning holistically.

Cluster 5 is shown with a visualization of a purple circle consisting of 11 keywords, including "academic achievement"; "adolescent"; "analysis of covariance"; "animal model"; "article"; "high school"; "problem solving"; "skill"; "student engagement"; "teacher"; "thinking". In cluster 5, the most frequently mentioned keywords are "article" with a total of 8 events, 50 connections, and has a link strength of 105. Cluster 6 is shown with a light blue circle visualization consisting of 10 keywords, including "attitude"; "biology"; "curriculum"; "laboratories"; "laboratory"; "perception"; "questionaire"; "student"; "surveys and questionaire"; "university". In cluster 6, the most frequently

mentioned keywords are "student" with a total of 9 events, 47 connections, and 94 link strengths. Cluster 5 (purple) and cluster 6 (light blue) are more related to methodological aspects and characteristics of students, such as academic achievement, student engagement, attitude, and perception. This shows that the research focuses not only on learning outcomes, but also on affective factors and learning processes. Implicitly, the success of guided inquiry is not only determined by the learning design, but also by the involvement and perception of students in the learning process.

Finally, cluster 7 is shown with an orange circle visualization consisting of 7 keywords, including "knowledge"; "learning"; "literacy"; "scaffolding"; "secondary education"; "suitanability"; "undergraduate student". In cluster 7, the most frequently mentioned keywords are "learning" with a total of 11 events, 59 connections, and 119 link strengths. Based on these results, it is proven that each cluster has similar characteristics, supports and is interrelated with each other. Meanwhile, cluster 7 (orange) which includes keywords such as learning, literacy, and scaffolding shows the importance of pedagogical support in the implementation of guided inquiry. The presence of the scaffolding concept emphasizes that teacher guidance is a key element in ensuring the effectiveness of guided inquiry learning. This strengthens the main characteristic of guided inquiry, namely the balance between student independence and teacher support in the scientific inquiry process.

Overall, the results of this analysis show that research on guided inquiry is developing towards integration between the development of critical thinking skills, science literacy, and 21st century competencies. However, there is still a general trend in research that has not specifically examined the conceptual relationship between guided inquiry, critical thinking skills, and science literacy in depth. Therefore, further research is needed that focuses more on the integration of these three aspects, especially in the context of science learning at the school level.

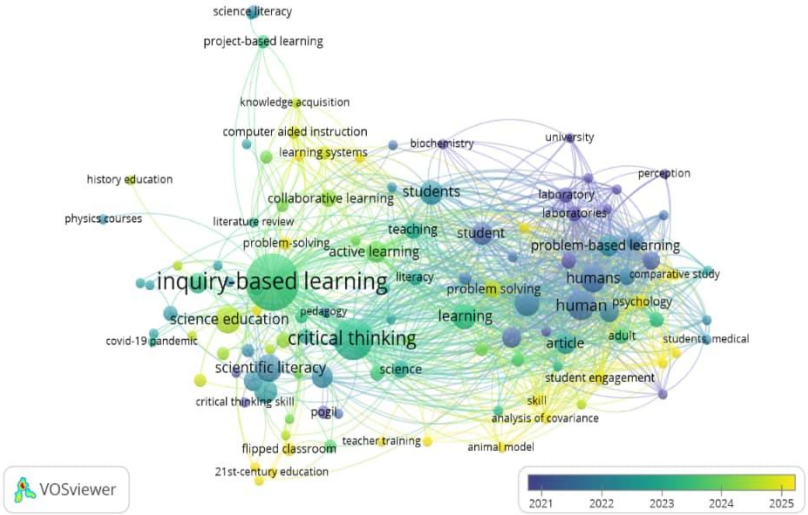

Figure 5. Keyword mapping by year of publication

Potential for new research innovations in related fields

In the Vosviewer software, there are 3 visualization views in bibliometric analysis, namely network, Overlay, and density visualization. Network functions to show the network between the visualized terms, if the trajectory or network in bibliometric analysis is in bold print, then it shows

a relationship between one term (term) and another (term) that is quite numerous and strong, on the other hand if the relationship between one term (term) is thin printed with small circles, then it shows a weak relationship between the observed terms (terms). The overlay functions to display the historical traces of the research, The darker the visualization of bibliometric analysis, it shows that the research has been carried out for longer to be done, if the visualization shows a light color, then the research will be carried out in the near future. The last visualization is density, density functions to display the density or emphasis on the research group. This bibliometric analysis visualization can be used to determine the part of research that is still rarely done or that has been done a lot (Nurul & Winoto, 2022). For example, in the period 2016 to 2026, the Overlay visualization section of 2016 will be displayed in the form of a dark network, and will be brighter in the following years. This shows that in 2026 the brightest network will be displayed.

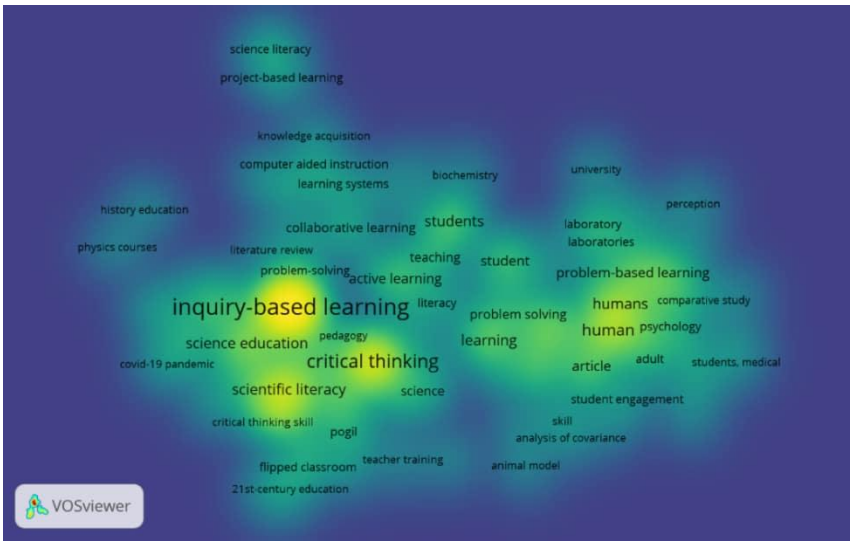

Figure 6. Keyword density

Figure 5 provides an overview of the novelty of research keywords based on the year of publication of the article (2016—2026). The color represents the average number of publications each year (Septiyanto et al., 2022). The brighter the color of the circle and the surrounding tissue, the newer the research. On the other hand, the darker color indicates older research. From Figure 5, it can be concluded that the research topic regarding learning systems, flipped classroom, 21ST-century education, critical thinking, inquiry-based learning, student engagement, problem solving, and science education. In particular, the topics highlighted in the brightest colors include inquiry-based learning, critical thinking and scientific literacy. Therefore, research that integrates inquiry-based learning models with critical thinking and scientific literacy skills has potential and deserves further research.

Meanwhile, the density of the mapped keywords is shown in Figure 6. The brighter the color, the higher the density or amount of research conducted on the theme (Astuti et al., 2023). The results of the analysis show that keywords such as Inquiry-based learning, critical thinking, scientific literacy, science education, and human psychology have been studied extensively. In contrast, keywords with fainter or darker colors represent topics that have potential for future research development. They have not been studied extensively, especially regarding their relationship with the application of inquiry-based learning models with critical thinking and

scientific literacy skills. Examples: science literacy, project-based learning, flipped classroom, and 21st st-century education

From Figures 7 and 8 innovative new research topics can be formulated. Lines connecting one keyword to another indicate the research relationship of the published article. A longer distance may indicate a less explored relationship between these contexts. Figure 6 illustrates a research network on the keyword "guided inquiry model in critical thinking skills" showing potential novelty when it comes to active learning, project-based learning, student engagement, learning, education, science literacy and digital literacy. On the other hand, Figure 7 illustrates a research network on the keyword "guided inquiry model in science literacy" with the potential for novelty in several topics such as ethnoscience, learning, education, argumentation and critical thinking. If these keywords intersect with "guided inquiry" and "critical thinking, science literacy", the potential to link them becomes greater.

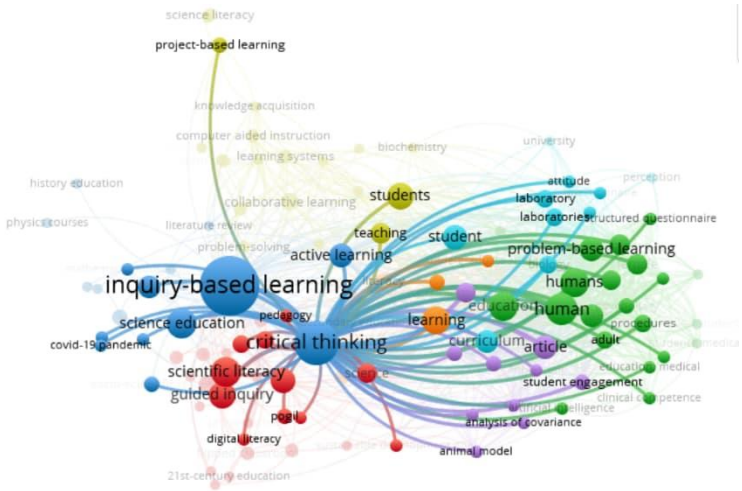

Figure 7. Research network on the keyword "guided inquiry in critical thinking"

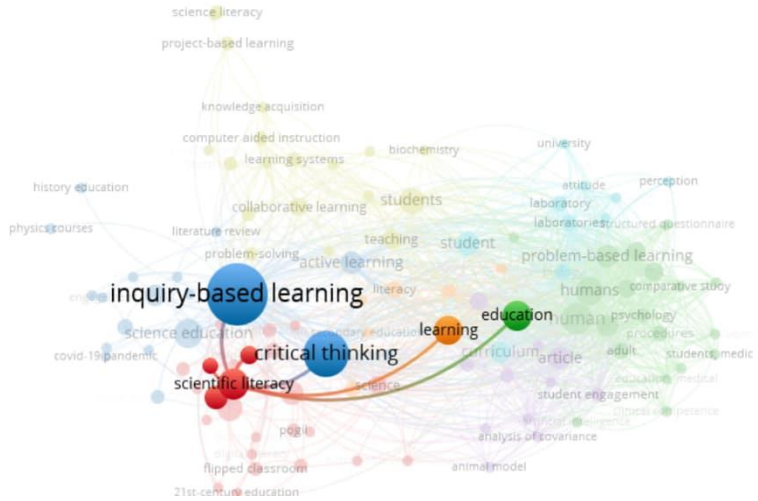

Figure 8. Research network on the keyword "guided inquiry in science literacy"

Actionable strategies to integrate *guided inquiry* in critical thinking skills and science literacy

In research based on the guided inquiry learning model in improving students' critical thinking skills and science literacy, several research findings support the same implementation in implicit or explicit linkages as shown in Table 2. A total of 10 articles were found sourced from various Scopus indexed journals, with research conducted in various countries, especially in Indonesia and Spain. This is in accordance with research conducted by (Yaumie et al., 2025) which explains that Indonesia is one of the countries with a high number of guided inquiry research both in terms of the number of publications and citations in the guided inquiry model study in critical thinking and science literacy. The accurate reason for this difference is that some irrelevant sources on the topic discussed are omitted in the analysis and synthesis stage. Moreover, the analyzed articles were only published from 2016 to 2026.

Table 2. Synthesis of 10 articles relevant to the guided inquiry model in critical thinking and science literacy

Author	Title	Country	Journal	Quotes
Kang (2022)	Interrelationship Between Inquiry-Based Learning and Instructional Quality in Predicting Science Literacy	Finland	Research in Science Education	39
Aiman et al. (2020)	The influence of process oriented guided inquiry learning (POGIL) model assisted by realia media to improve scientific literacy and critical thinking skill of primary school students	Indonesia	European Journal of Educational Research	35
Duran & Dökme (2016)	The effect of the inquiry-based learning approach on student's critical-thinking skills	Turkey	Eurasia Journal of Mathematics, Science and Technology Education	197
Arifin et al. (2025)	The effect of inquiry-based learning on students' critical thinking skills in science education: A systematic review and meta-analysis	Indonesia	Eurasia Journal of Mathematics, Science and Technology Education	13
Arana-Cuenca et al. (2025)	Self-Perception of Critical Thinking in High School Students Through Scientific Inquiry on DNA Extractio	Spain	Educational Process: International Journal	1
Sapriati et al. (2024)	The Impact Of Inquiry-Based Learning on Students' Critical Thinking in Biology Education Programs Within Open and Distance Learning Systems	Indonesia	Indonesian Journal of Science Education	13
Kunnath & Botes (2025)	Transforming science education with artificial intelligence: Enhancing inquiry-based learning and	South Africa	Eurasia Journal of Mathematics, Science and Technology Education	2

	critical thinking in South African science classrooms			
Dewi et al. (2021)	Inquiry-based learning implementation to improve critical thinking of prospective teachers	Indonesia	International Journal of Information and Education Technology	7
Romero-Ariza et al. (2020)	Highly Recommended and Poorly Used: English and Spanish Science Teachers' Views of Inquiry-based Learning (IBL) and its Enactment	Spain	Eurasia Journal of Mathematics, Science and Technology Education	31
Santana Vega et al. (2020)	Inquiry-based learning in the university context: A systematic review	Spain	Spanish Journal of Pedagogy	20

A relevant learning model to be integrated with students' science literacy and critical thinking is a guided inquiry learning model (Guided Inquiry). This model actively involves students in the process of scientific research through the stages of problem formulation, data collection, analysis, and drawing conclusions with the guidance of the teacher (Safitri et al., 2021). Various studies have shown that the application of guided inquiry can improve scientific thinking skills, scientific attitudes, and learning outcomes of students (Amalia & Kuntjoro, 2026; Heksa, 2020). The guided inquiry learning model is particularly suitable for economics subjects because it supports the application of abstract economic concepts in real-world contexts, develops analytical and critical thinking skills, and encourages active engagement and reflection. Guided inquiry learning requires learners to seek and gain the knowledge they need through inquiry and inquiry (Sari et al., 2025).

Several studies have shown that inquiry-based learning is effective in improving science literacy. Research conducted by Prodjosantoso (2024) showed that SSI-based inquiry learning significantly improved students' chemical literacy, with a contribution of 80.90% to its improvement. In addition, 82% of students involved in this learning approach showed good chemistry literacy, which showed its effectiveness in improving science literacy. Furthermore, research conducted by Zulaika et al. (2022) explained that the results of the hypothesis test showed that there was an influence of the guided inquiry learning model on the Science Literacy Ability of class X students in biodiversity material as shown by a sig value of 0.02 less than an alpa value of 0.05. In line with the findings of the research Istiqomah & Hariyono (2019) which explains the average N-Gain results of the three classes of the improvement of students' science literacy skills occurred after the implementation of the Guided Inquiry.

The guided inquiry learning model is a learning activity process that requires students' thinking patterns to be critical and analytical in finding and finding answers on their own from a problem asked in the question (Muliani & Wibawa, 2019). Guided inquiry learning has characteristics, first, emphasizing the activities of students optimally to search and create. Second, all activities carried out by students are aimed at finding and creating their own answers to a question. Third, the purpose of learning is to improve high-level thinking skills such as logical thinking, critical thinking or improving intellect (Arif & Asikhin, 2022). The series of activities in guided inquiry learning optimally links all students' skills to search and investigate systematically, critically, logically, analytically, so that they can create their own discoveries with confidence (Masitoh et al., 2017).

4. Conclusion

During the period 2016–2026, research on the application of the guided inquiry model to improve critical thinking skills and science literacy showed a significant upward trend, peaking in 2025. The results of the bibliometric analysis identified seven main clusters, with keywords such as guided inquiry, inquiry-based learning, critical thinking, and scientific literacy, indicating a research focus on developing high-level thinking skills through inquiry-based learning. Furthermore, this study produces a conceptual synthesis that the effectiveness of guided inquiry in improving science literacy and critical thinking is influenced by three main components, namely: (1) a structured inquiry process, (2) pedagogical support (scaffolding) from teachers, and (3) integration with innovative learning contexts such as digital technology and project-based learning. These findings show that the success of guided inquiry depends not only on the learning model but also on the design and context of its implementation. In addition, overlay and density analyses show that topics such as inquiry-based learning, critical thinking, and scientific literacy are still evolving, and there are research opportunities to integrate guided inquiry with other innovative approaches. Thus, the contribution of this research lies in the comprehensive mapping and the development of a conceptual framework for the relationship among guided inquiry, critical thinking skills, and science literacy. Further research is suggested to test this framework empirically across various educational contexts to develop more effective, context-specific science learning.

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