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Literature Review: The Influence of the Inquiry Learning Model on Increasing Scientific Attitudes in Science Learning

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Abstract: This study is a literature review that aims to explore the influence of the Inquiry Learning model on improving scientific attitudes in science learning. The scientific attitudes in question include curiosity, objectivity, openness to evidence, and perseverance in the process of seeking the truth. Using the analytical descriptive method, data were collected from 1,000 Google Scholar indexed documents between 2020 and 2025, then analyzed using software such as Publish or Perish, Dimension.ai, and VOSviewer. The results of the study show that the inquiry learning model, both guided, laboratory-based, and integrated with concrete media and digital technology, significantly contributes to improving students' scientific attitudes. Bibliometric visualization shows that this topic is a major trend in scientific publications, with a dominant distribution in journal articles. This study also found that the integration of social, cultural, and spiritual aspects in the inquiry approach has a positive impact on the formation of students' scientific character. However, there is still room for further exploration on themes such as mobile learning and inquiry frameworks that have not been widely studied. Thus, inquiry learning is not only relevant in building students' scientific foundations, but also becomes a strategic approach that is adaptive to the needs of 21st century learning. The implications of this study point to the importance of implementing inquiry learning models widely at various levels of education.

Keywords: Literature Review; Scientific Attitude; Inquiry Learning; Science Learning

Introduction

The development of students' scientific attitudes is one of the important goals in science learning. Scientific attitudes include curiosity, objectivity, openness to evidence, and persistence in seeking scientific truth. The inquiry learning model has been identified as an effective model for fostering these attitudes. According to Sari and Lahade (2022), the application of the inquiry learning model significantly influences scientific attitudes, namely the curiosity of elementary school students in science learning, with a contribution of 61.6% to improving students' scientific attitudes.

Furthermore, the guided inquiry approach utilizing concrete media also shows a positive impact on students' scientific attitudes. Suryantari, Pudjawan, and Wibawa (2019) found that the use of a guided inquiry model assisted by concrete media significantly improved the scientific attitudes and science learning outcomes of elementary school students. This shows that the integration of concrete media in inquiry learning can strengthen students' understanding of scientific concepts and attitudes.

In addition, the application of laboratory-based guided inquiry models is also effective in improving students' scientific attitudes. Maretasari, Subali, and Hartono (2012) reported that this approach not only improves learning outcomes, but also students' scientific attitudes significantly. Laboratory activities designed with an inquiry approach allow students to experience the scientific process directly, thereby strengthening their scientific attitudes.

In the context of Islamic education, Lestari (2020) examined the effectiveness of the guided inquiry learning model in improving scientific attitudes and critical thinking skills of students at MIN 1 Serang. The results showed that this model was effective in improving both aspects, with the average value of students' scientific attitudes in the experimental class reaching 87.6% compared to 56.6% in the control class.

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This confirms that the guided inquiry model can be widely applied in various educational contexts to improve students' scientific attitudes.

Parwati et al. (2024) also studied the effect of guided inquiry learning models on students' critical thinking skills and scientific attitudes. Their research used a quasi-experiment involving 49 eighth grade students of SMP Widiatmika. The results of the MANOVA analysis showed that the guided inquiry learning model significantly improved students' critical thinking skills and scientific attitudes compared to the direct learning model.

These studies show that inquiry learning models, both in guided and laboratory-based forms, are effective in improving students' scientific attitudes in science learning. Therefore, it is important to continue to study and implement this approach in learning practices to achieve holistic science education goals.

Method

This research method is descriptive analytical, which aims to understand and describe literature review: the effect of the Inquiry Learning model on improving scientific attitudes in science learning. The data used in this study were obtained from information sources indexed by Google Scholar using analysis tools such as Publish or Perish and Dimension.ai. To conduct a search on Google Scholar, namely searching for keywords related to the literature review: the effect of the Inquiry Learning model on improving scientific attitudes in science learning.

In this study, an analysis was conducted on 1,000 documents that have been indexed by Google Scholar between 2020 and 2025. The Google Scholar database was chosen as a place to search for documents because Google Scholar applies consistent standards in selecting documents to be included in its index, and Google Scholar displays more documents than other top databases, especially research in the field of

education (Hallinger & Chatpinyakoop, 2019; Hallinger & Nguyen, 2020; Zawacki-Richter et al., 2019). In addition to processing data using Publish or Perish and Dimension.ai, researchers also used VosViewer as a tool to view networks, overlays, and the density of previously searched keywords. The methods used include quantitative analysis using VOSviewer software to visualize data and qualitative content analysis for interpreting text data

Result and Discussion

This study aims to describe the literature review: the influence of the Inquiry Learning model on improving scientific attitudes. The literature review research document: the influence of the Inquiry Learning model on improving scientific attitudes in science learning is taken from documents from 2020 to 2025. The following is Figure 1 regarding the literature review: the influence of the Inquiry Learning model on improving scientific attitudes in science learning.

Figure 1 shows that the literature review: the influence of the Inquiry Learning model on improving scientific attitudes in science learning has increased and decreased. Where the research trend with a slight decrease in the number of publications from 2020 to 2021. However, in 2021 to 2023 there was an increase and in 2023 to 2024 the literature review: the influence of the Inquiry Learning model on improving scientific attitudes in science learning experienced a slight decrease.

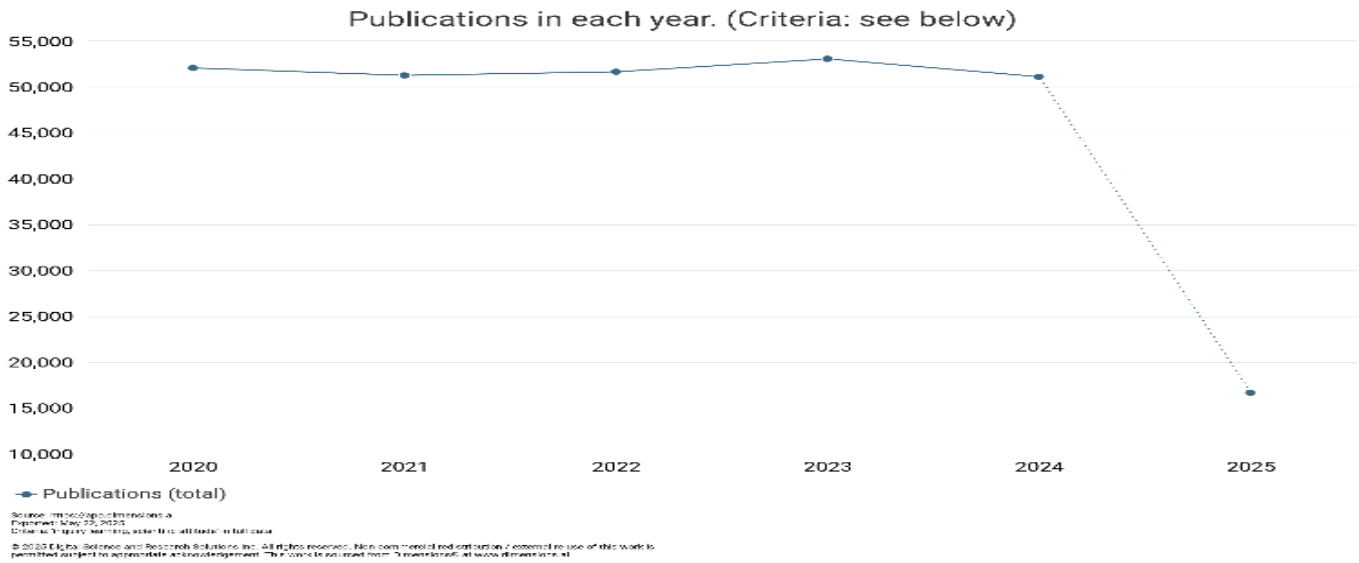

Figure 1. Chart Literature Review: The Influence of the Inquiry Learning Model on Increasing Scientific Attitudes

Table 1. Literature Review: The Effect of Inquiry Learning Model on Improving Scientific Attitudes Based on Publication Type

Publication Type	Publication
Article	312,446
Chapter	214,183
Edited Book	121,419
Monograph	116,980
Preprint	10,699
Proceeding	8,426

Table 1 shows the distribution of scientific publications examining the influence of the Inquiry Learning model on improving scientific attitudes based on the type of publication. The most common type of publication found was scientific articles (articles) with a total of 312,446. This shows that scientific articles are still the main choice in disseminating educational research results, especially those related to the Inquiry Learning model. Scientific articles are considered quickly accessible, easy to publish in reputable journals, and relevant to the development of learning practices. Scientific articles make a major contribution to developing a database of empirical studies in education because of their dynamic nature and frequent updates. A scientific article is a complete written work, for example a news report, newspaper, and so on, or it can also be a composition/prose published in the mass media, which discusses certain issues, problems, or cases that are developing in society in a straightforward manner. A scientific article is a form of scientific work that is written based on a guideline or procedure for scientific writing so that it can be accounted for (Karomah & Rizal, 2022).

The second largest type of publication is book chapters, with a total of 214,183. These publications usually appear in books that compile various perspectives or studies related to a particular theme. Book chapters provide more space for theoretical and applied discussions of the Inquiry Learning model, which is very suitable for in-depth discussions of learning strategies and students' scientific attitudes. According to research by Rahmawati & Ramadhan (2021), publications in the form of book chapters have the advantage of presenting study results in a more systematic and integrated context.

In third place is the edited book with a total of 121,419 publications. This edited book usually contains a collection of writings from various authors edited by expert editors in the field of education or pedagogy. This type of publication provides a variety of views and research results from various contexts that enrich the understanding of the implementation of Inquiry Learning. Edited books allow the integration of theory and practice in one in-depth and contextual volume. Qablan et al. (2024) in Inquiry-Based Learning: Encouraging Exploration and Curiosity provide empirical evidence that the writings collected in edited books can include the development of constructivist theory to examples of implementation in real classrooms.

Monographs, numbering 116,980, are also an important part of the dissemination of scientific information. Monographs usually discuss a particular topic in a complete and comprehensive manner, making them suitable for exploring the concept and application of Inquiry Learning in depth in one field or discipline. Monographs are often used by senior researchers or higher education institutions to emphasize the inquiry-based learning approach as a philosophical and methodological foundation.

A monograph is defined as a piece of writing that focuses on a particular topic or subject, arranged in depth and comprehensively. Unlike scientific articles which are generally more concise, monographs allow authors to explore a topic more broadly and in detail. Monographs are an effective means of disseminating research results, especially for lecturers and researchers who want to convert their scientific work into book form. This not only expands the reach of readers but also increases the academic value of the research. Monographs can also serve as important references in certain scientific fields, making a significant contribution to the development of science (Fatmawati, 2020).

The number of preprint publications, 10,699, shows researchers' interest in sharing their research results openly before going through the formal peer-review process. Preprints provide the advantage of accelerating the dissemination of ideas, which is very important in the ever-evolving field of education. Preprints are increasingly in demand in the open science ecosystem as an initial step to validate ideas before being officially published. According to Fraser et al. (2021), preprints are important as an effective scientific communication tool, especially in emergency situations such as pandemics. Preprints enable the rapid dissemination of research results before going through the formal peer-review process, which is critical for a rapid response to a public health crisis.

Finally, publications in the form of proceedings were recorded at 8,426. Although the number is the smallest, conference proceedings are still important because they present the latest research results, including the development of the Inquiry Learning model and its influence on students' scientific attitudes. Proceedings are often the first step before developing more mature work in the form of journal articles. This process is common in many disciplines, as proceedings allow for feedback and refinement before formal publication. Kochetkov et al. (2020) stated that

proceedings are often an important evaluative source and have the potential to be developed into high-quality journal articles.

Table 2 also presents ten (10) trends in research source titles on the inquiry learning model to improve scientific attitude skills in science learning which are often cited by other researchers.

Table 2. Top 10 Sources Title Trends of Inquiry Learning Model to Improve Scientific Attitude Skills in Science Learning in 2020-2025

Name	Publications	Citations	Citations Meaning
Behavioral and Brain Sciences	9,368	200,914	21.45
Lecture Notes in Computer Science	3,457	22,741	6.58
Critical Care	2,416	2,642	1.09
HortScience	2,381	1,985	0.83
Frontiers in Psychology	2,083	33,976	16.31
Sustainability	2,069	42,588	20.58
Encyclopedia of the UN Sustainable Development Goals	2,003	2,166	1.08
Journal of the Royal Anthropological Institute	1,914	2,734	1.43
Advances in Social Science, Education and Humanities Research	1,517	1,688	1.11
Encyclopedia of Indian Religions	1,489	145	0.10

Table 2 presents the top ten publication sources that are trending in presenting titles related to the Inquiry Learning model to improve scientific attitude skills in science learning. Judging from the number of publications and citations recorded, the Behavioral and Brain Sciences journal ranks first with a total of 9,368 publications and 200,914 citations, resulting in an average citation of 21.45. This shows the high influence and relevance of this journal to the development of inquiry-based education, especially in the context of behavioral psychology and scientific cognition.

Furthermore, Lecture Notes in Computer Science (LNCS) recorded 3,457 publications with 22,741 citations and an average of 6.58 citations per publication. Although the field focuses on computer science, publications in LNCS show important contributions to technology-based learning models integrated with inquiry approaches. The integration of digital technology in science learning through an inquiry approach can significantly increase student motivation and engagement. Siregar et al. (2022) in the BIODIK journal studied innovations in biology learning by integrating digital technology into a guided inquiry model. They used various devices such as Liveworksheet, smartphones, and environmental sensors to increase learning effectiveness. The results showed that the integration of this technology can increase the meaning and benefits of biology learning for students.

The Critical Care and HortScience journals have 2,416 and 2,381 publications respectively, with relatively low average citations (1.09 and 0.83). However, these two journals indicate the relevance of the inquiry approach in the fields of health and applied biology such as problem-based learning and inquiry are also implemented in medical and agricultural contexts to develop critical thinking skills and scientific attitudes of prospective professionals. This is in accordance with the research of Parwati et al. (2024) which examined the effect of the guided inquiry learning model on students' critical thinking skills and scientific attitudes in science learning. The results of the study showed that this approach was effective in improving both aspects, which are essential in forming prospective professionals in the fields of science, including medicine and agriculture.

The journals Frontiers in Psychology and Sustainability also showed significant contributions, with 2,083 and 2,069 publications respectively, and high citation averages (16.31 and 20.58). This indicates that the integration of psychological aspects and sustainability issues in inquiry-based science learning is very relevant today. Research by Sulistina et al. (2021) emphasized the influence of guided inquiry-based learning using socio-scientific issues on the environmental awareness of prospective chemistry teachers. This study found that this approach increased participants' environmental awareness, especially in terms of optimism towards the environment.

*Encyclopedia of the UN Sustainable Development Goals*and the Journal of the Royal Anthropological Institute display quite high publications, although the average citation per article is low. This could be due to the referential and descriptive nature of encyclopedias and anthropology journals which are more theoretical in nature. Nevertheless, the literature from these sources remains an important reference in linking inquiry learning with global contexts and local cultures. According to Tiarawati and Rahmantika (2021) in their literature review, they emphasized that learning based on the social and cultural environment can be effective in developing student characteristics, including scientific attitudes. By linking subject matter to students'

social and cultural contexts, learning becomes more meaningful and relevant.

Other sources such as Advances in Social Science, Education and Humanities Research and Encyclopedia of Indian Religions despite having significant number of publications (1,517 and 1,489), recorded low average citations, especially Encyclopedia of Indian Religions (0.10). However, its contribution lies in the multidisciplinary approach to education based on values and spirituality, which is increasingly relevant in developing scientific attitudes that are not only cognitive, but also affective and ethical. This is reinforced by Basri's study (2021) which emphasizes the importance of science learning rooted in local values and spirituality. His study shows that combining the kauniyah (natural phenomena) and qauliyah (revelation) aspects in science learning can strengthen students' spiritual understanding of scientific concepts. This approach helps students see the connection between science and faith, thus encouraging them to appreciate God's creation more through scientific understanding.

Also presented below is a table of 3 trends of the top ten (10) article titles in research on the Inquiry learning model to improve scientific attitude skills in science learning that are frequently cited by other researchers.

Table 3. Top 10 Quotes About Inquiry Learning Model Trends to Improve Scientific Attitude Skills in Science Learning in 2020-2025

Cites/Year	Year	Author	Title
1281.00	2020	HE Longino	Science as social knowledge: Values and objectivity in scientific inquiry
17.40	2020	A Thahir, C Anwar, A Saregar, L Choiriah, F Susanti and A Pricilia	The Effectiveness of STEM learning: scientific attitudes and students' conceptual understanding
17.40	2020	Ikhsan, Jaslin	Effect of 3D Visualization on Students' Critical Thinking Skills and Scientific Attitude in Chemistry.
16.40	2020	DT Brookes, E Ektina, G Planinsic	Implementing an epistemologically authentic approach to student-centered inquiry learning
7.25	2021	NKD Utariadi, IM Gunamantha and IN Suastika	Development of LKPD based on scientific approach to improve students' scientific attitudes in theme 9 subtheme 1 of science subject matter for grade V
2.80	2020	H Taib, A Haerullah, C Roini	The influence of guided inquiry learning on junior high school students' science process skills
2.75	2021	Mailita Sari Pulungan, Derlina Nasution and Rahmatsyah	The effect of scientific inquiry learning model and scientific attitude on students' science process skills
2.20	2020	F Mayangsari, Yusrizal and Mustafa	Application of guided inquiry learning model to improve students' scientific attitudes and learning outcomes
0.50	2023	UA Mu'min, BM Khutomi and Herri Azhari	The Influence of Student Inquiry and Curiosity Level on The Learning Outcomes of The Cognitive Aspects of History of Islamic Culture Subject
0.00	2025	R Febriyanti, EW Laksono	The effect of guided inquiry with socio-scientific issues (SSI) approach on students' higher order thinking skills and scientific attitudes of salt hydrolysis material

Table 3 displays the top ten most cited publications per year (Cites/Year), illustrating the trends and influence of scientific literature in the development of the Inquiry Learning model to improve students' scientific attitudes in science learning.

The highest cited publication comes from HE Longino (2020) entitled Science as Social Knowledge: Values and Objectivity in Scientific Inquiry with 1281 citations per year. Longino highlights that science is not a neutral process, but is full of social values and objectivity that are built collectively through scientific inquiry. This idea strengthens the argument that inquiry-based learning must engage students in social, collaborative, and reflective processes, which support the formation of scientific attitudes such as being open to evidence, honest, and unbiased.

A subsequent publication by Thahir et al. (2020) examined the effectiveness of STEM learning in improving students' scientific attitudes and conceptual understanding. With 17.40 citations per year, this article shows that the integration of science, technology, engineering, and mathematics through an inquiry approach can encourage students to think critically and scientifically in solving contextual problems. Science learning that is linked to real life has been shown to encourage active and responsible attitudes in the learning process.

Research by Astuti et al. (2020) with similar citations (17.40) examined the effects of 3D visualization on students' critical thinking skills and scientific attitudes in chemistry material. They concluded that inquiry-based visual technology encourages students to

actively explore, formulate questions, and draw conclusions based on observations. This strengthens the finding that interactive visual approaches are very effective in supporting the formation of analytical and reflective scientific attitudes.

Furthermore, Brookes et al. (2020) proposed an authentic epistemological approach in student-centered inquiry learning. With 16.40 citations per year, this study emphasizes the importance of the epistemic structure of science learning, namely that students must experience the process of thinking of scientists—observing, doubting, evaluating, and concluding independently. This provides a philosophical foundation for the practice of inquiry learning in science classrooms.

Utariadi et al. (2021) compiled Student Worksheets (LKPD) based on a scientific approach to improve the scientific attitudes of elementary school students. With an annual citation of 7.25, this article makes a concrete contribution to the preparation of applicable inquiry-based teaching tools. This LKPD has been proven to increase students' perseverance, curiosity, and responsibility in thematic science learning.

Research by Pulungan et al. (2021) and Taib et al. (2020) strengthens the effectiveness of the guided inquiry model on the science process skills and scientific attitudes of junior high school students. With quotes of 2.75 and 2.80, both reveal that systematic guidance in exploration, experimentation, and reflection provides space for the development of scientific attitudes such as being thorough and honest.

Mayangsari et al. (2020) through applied research showed that the implementation of guided inquiry in biology classes can significantly improve students' learning outcomes and scientific attitudes. The average citation of 2.20 per year reflects the contribution of his articles to active and collaborative science learning practices.

More recent studies by Mu'min et al. (2023) and Febriyanti & Laksono (2025) show a trend of combining inquiry models with cultural contexts and socio-scientific issues (SSI). Although citations are still low due to their recent publication, this direction promises to increase the understanding of science integrated with real-life values and contexts. Also presented below is a table of 4 ten (10) keywords on the Inquiry learning model trend to improve scientific attitude skills in science learning which are often cited by other researchers.

Table 4 shows a number of keywords that often appear in the literature related to the inquiry learning model in the context of improving students' scientific attitude skills in science learning. The keyword "scientific attitude" was recorded as appearing 17 times with a relevance of 0.64. This confirms that scientific attitude is one of the main focuses in recent studies, in line with the findings of Siahaan (2023) in his research showing that inquiry-based learning models can improve creative thinking skills, curiosity, and self-confidence in early childhood students.

Table 4. Keywords on Inquiry Learning Model Trends to Improve Scientific Attitude Skills in Science Learning in 2020-2025

Provision	Emergence	Relevance
Scientific attitude	17	0.64
Inquiry learning model	15	1.30
Science inquiry	18	0.83
Creativity	14	0.65
Active learning	20	0.66
scientific literacy	25	0.76
Scientific process	12	2.93
Science teaching	17	0.73
Critical Thinking Skill	29	0.94
Learning Process	33	0.89

Furthermore, the keyword "inquiry learning model" appeared 15 times with a high relevance score of 1.30. This shows that this learning model continues to be a dominant approach in efforts to improve the quality of science learning. Inquiry learning is able to encourage students to actively explore scientific phenomena and build their own knowledge independently and critically. Where in research by Mahyuna et al. (2024) in the article "Independent Learning with a Guided Inquiry Approach: Training Students' Critical Thinking Skills in Science Learning". This study emphasizes that the guided inquiry approach allows students to be actively involved in the process of exploration, observation, and drawing conclusions based on evidence. This approach is considered effective in developing students' critical thinking skills, which are important in facing the challenges of the 21st century.

The occurrence of the word "science inquiry" 18 times with a relevance of 0.83 also reflects a strong focus on the scientific inquiry approach in the learning process. The application of science inquiry allows students to engage in the complete scientific thinking process, from observation to drawing conclusions, which is very important in developing deep conceptual understanding. Aras et al. (2021) research compared the effectiveness of guided inquiry models with conventional methods in improving students' conceptual understanding and science process skills. The results showed that students who learned with guided inquiry models had higher average conceptual understanding scores compared to students who learned with conventional methods.

Interestingly, the word "creativity" also appears 14 times with a relevance of 0.65. This shows a close relationship between inquiry learning and the development of student creativity. The inquiry

approach facilitates students to think divergently and produce innovative solutions to complex problems, making creativity one of the important learning outcomes in science. Marfilinda's research (2025) found that the inquiry learning model significantly increased students' learning creativity in science subjects. The participatory and exploratory approach encourages students to actively participate and explore their knowledge, supporting the development of creative ideas.

In addition, "active learning" is a keyword with a frequency of 20 and a relevance of 0.66, indicating that inquiry learning is in line with the principles of active learning. Active student involvement in inquiry learning has been proven to increase motivation and participation in a more meaningful and contextual science learning process. Ratnaningrum et al. (2015) found that the use of guided inquiry learning models can improve students' motivation and learning outcomes in science subjects. Students involved in this learning showed increased enthusiasm for learning and active participation in class activities, which contributed to better understanding of concepts.

"Scientific literacy" appeared 25 times with a relevance of 0.76, indicating the urgency of scientific literacy in today's education. Inquiry-based learning has great potential in shaping scientific literacy, because students are required to understand scientific concepts and be able to apply them in real-life contexts. Jannah et al. (2024) revealed that the guided inquiry learning model is effective in improving students' scientific literacy skills, especially in the material of liquid pressure. The results of the analysis showed a significant increase in students' understanding of scientific concepts and their applications.

Meanwhile, "scientific process" showed the highest relevance score of 2.93 even though it only appeared 12 times. This indicates that even though it is not often mentioned, this concept has a high proximity to the main theme. The scientific process in inquiry learning includes activities such as observation, formulating problems, experiments, and data interpretation, which are essential in building students' scientific attitudes. In Widodo et al.'s (2024) research implemented an inquiry learning model that includes the following stages: orientation, formulating problems, formulating hypotheses, collecting data, testing hypotheses, and formulating conclusions. The results showed an increase in students' science process skills, such as observation, experimentation, and data interpretation skills. This increase also contributed to the development of students' scientific attitudes, including curiosity and perseverance.

The word "science teaching" appears 17 times (relevance 0.73), indicating that the inquiry approach is increasingly integrated into science teaching practices. Science teachers who adopt the inquiry learning model tend to be better able to guide students in logical and methodological thinking in accordance with the characteristics of science. This is in accordance with the opinion of Aidoo (2024) who stated that the experience of a science teacher in implementing an inquiry-based learning approach. Through reflection on teaching practices, the teacher observed that this approach encourages students to actively ask questions, think critically, and engage in scientific investigations. The teacher acts as a facilitator who guides students in the inquiry process, enabling them to develop logical and methodological thinking skills that are in accordance with scientific characteristics.

Next, "critical thinking skill" is the most frequently appearing keyword, which is 29 times with a relevance of 0.94. This strengthens the view that critical thinking skills are one of the main outcomes of inquiry-based learning. Inquiry learning stimulates students to analyze, evaluate information, and make rational, evidence-based decisions. This is in accordance with research conducted by Bakri et al. (2021), where in their research it was shown that the inquiry learning model has a significant influence on improving the critical thinking skills of grade 7 students. Students involved in inquiry learning showed better abilities in analyzing and evaluating information compared to students who participated in conventional learning.

Finally, the word "learning process" appeared 33 times with a relevance of 0.89, indicating that inquiry learning has a broad impact on the entire student learning process. Integration of inquiry into the learning process not only improves learning outcomes, but also forms students' independent and reflective learning character. This is in accordance with the findings of Hertiavi (2017) that the integration of guided inquiry models with character education is effective in improving the learning outcomes of junior high school students. This approach also contributes to the formation of independent and reflective student characters through active involvement in the learning process.

The following is a visualization achieved by creating a landscape map, which offers a visual representation of subjects related to scientific studies. The results of bibliometric mapping for the shared word network in articles related to the topic of the Inquiry Learning Model to improve scientific attitude skills in science learning are illustrated in Figure 2.

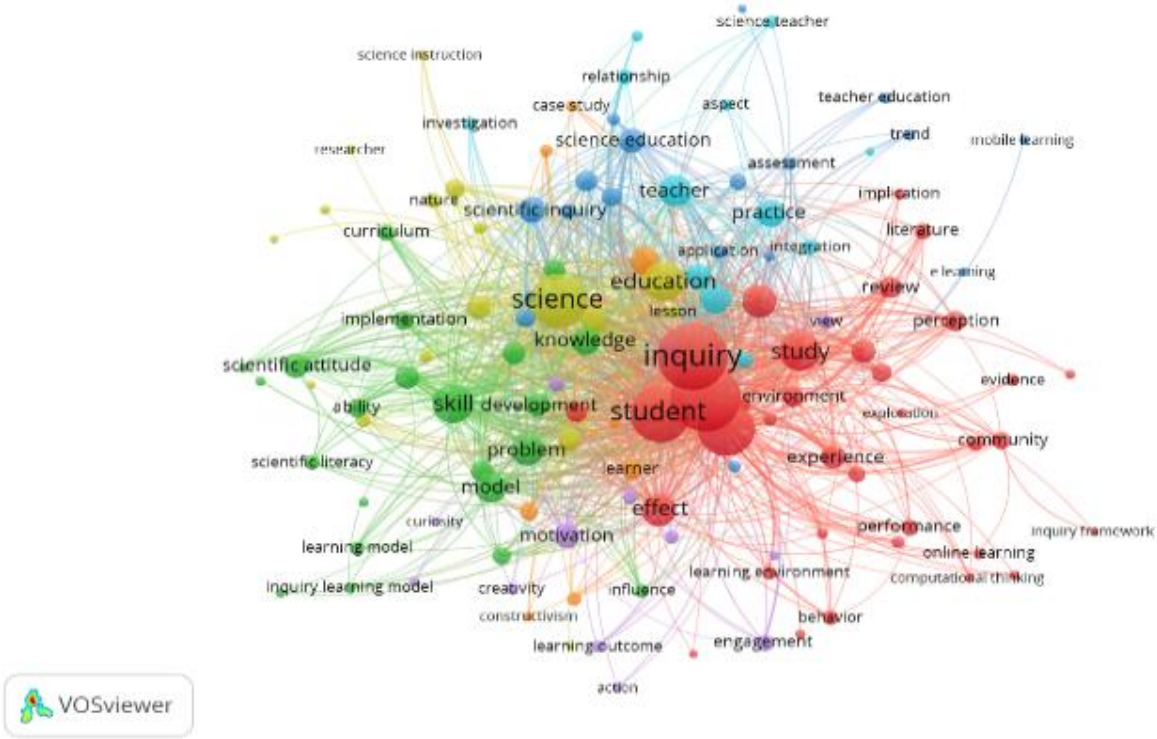

Figure 2. Network Visualization in Inquiry Learning Model to Improve Scientific Attitude Skills in Science Learning

The image shown is the result of bibliometric map visualization using VOSviewer software, which illustrates the relationship between keywords in various scientific publications. This visualization presents a network of relationships between terms that often appear in academic studies, especially in the fields of science education and inquiry-based learning approaches.

Each circle (node) in this visualization represents a keyword or term used in the publication. The size of the circle indicates the frequency of occurrence of the word, the larger the circle, the more frequently the word appears in the analyzed literature. Keywords such as inquiry, student, science, and education appear most dominant, indicating that issues around inquiry learning and the role of learners are the main focus in these studies.

In Figure 2, there are 125 keyword items that are often used in research on scientific attitude skills in science learning from 2020 to 2025. Figure 2 also contains 7 clusters, where the first cluster in red consists of 35 keyword items, namely inquiry, student, study, experience, effect, motivation and so on. This cluster is the center of visualization and shows that the main focus of the research is on the role of students and the influence of the inquiry approach on the learning process and outcomes. The second cluster in green consists of 22 keyword items, namely skill, scientific literacy, scientific attitude, learning model, and so on. This cluster illustrates the focus of research on the development of students' scientific skills, the use of constructivist learning models, and aspects of scientific literacy and attitudes that are fostered through the inquiry approach. The third cluster in dark blue consists of 18 keyword items, namely teacher education, science attitude, science education, application, and so on. The fourth cluster in yellow consists of 17 keyword items, namely activity, content, education, science, lesson, and so on. This cluster also includes science instruction and nature, which are related to the nature of science and exploration-based learning. The fifth cluster is purple, consisting of 13 keyword items, namely creativity, constructivism, curiosity, learning outcome, motivation, and so on. The focus of this cluster is on the influence of the inquiry approach on the development of creativity, curiosity, and student learning outcomes within the framework of constructivist theory. The sixth cluster is blue, consisting of 12 keyword items, namely aspect, engineering, integration, investigation, practice, present study, teacher, teaching, and so on. The seventh cluster is orange, consisting of 8 keyword items, namely active learning, case study, chemistry, learner, project, learning process, constructivism, and information.

The relationship between keywords is visualized as connecting lines (edges), which show the extent to which two keywords frequently appear together in the same

document. Thicker lines indicate stronger relationships or more frequent co-occurrence.

Overall, this visualization provides a comprehensive overview of the research map in the realm of science education, which shows that the inquiry-based learning approach is not only centered on students as the main subject of learning, but also includes aspects of teachers, curriculum, technology, and scientific skills development. Thus, the results of this visualization are very useful for researchers or educators to understand research trends, find research gaps, and formulate relevant keywords in developing further studies. Also presented below are keywords regarding the Inquiry Learning model to improve scientific attitude skills in science learning based on overlay visualization.

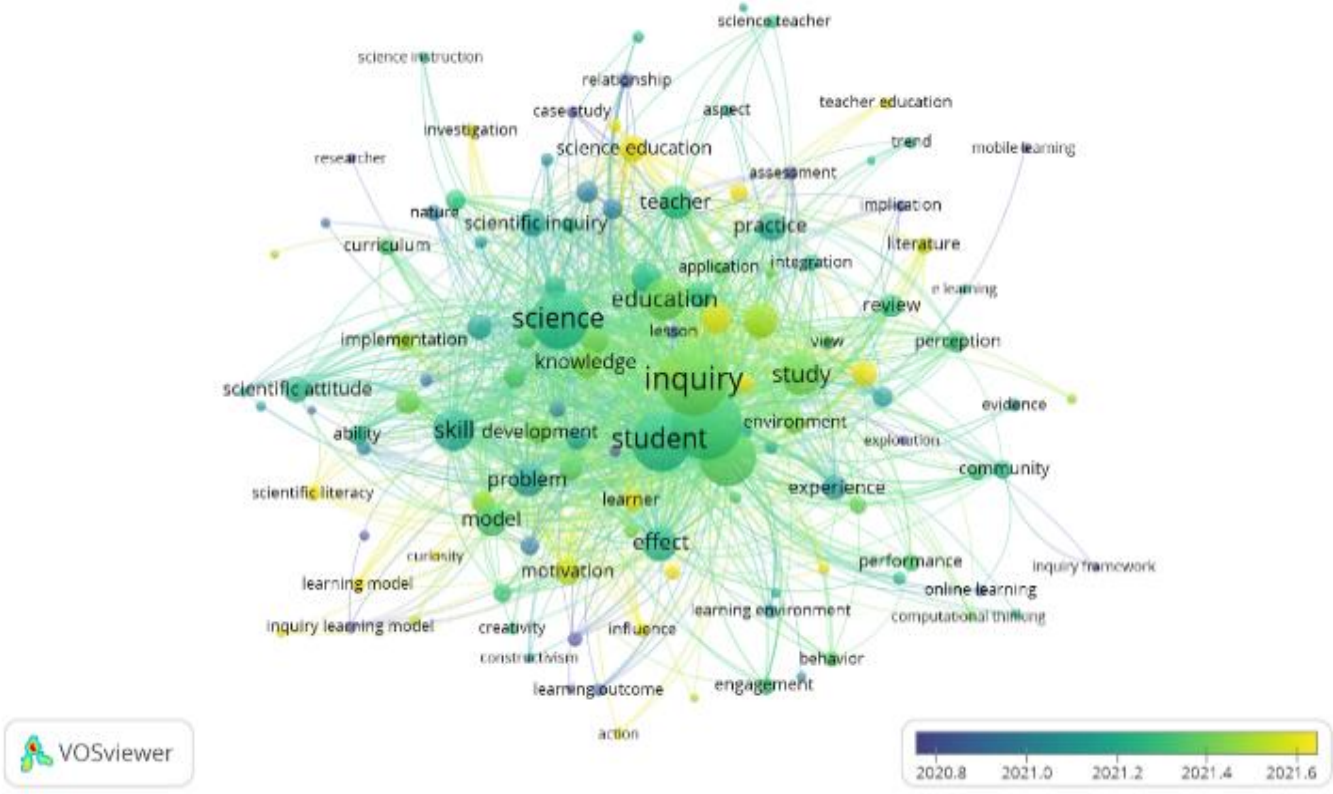

Figure 3. Overlay Visualization on Inquiry Learning Model to Improve Scientific Attitude Skills in Science Learning

Figure 3 shows the trend of keywords related to the Inquiry Learning model research to improve scientific attitude skills in science learning in Google Scholar indexed journals from 2020 to 2025. The theme of writing articles related to the inquiry learning model to improve scientific attitude skills in science learning from old to new years is marked by the color themes of purple, blue, turquoise, dark green, light green and yellow. The image above shows that the keywords learning outcome, inquiry learning model, lesson, assessment and others, indicate that these keywords are widely used by researchers in 2020. Hikmawati, Kusmiyati, & Sutrio (2020) in their study found that the implementation of the inquiry model significantly improved students' cognitive learning outcomes in the topic of temperature and heat (pre-test scores increased from 43 to 78, and classical complete 84%). Likewise, Ozturk, Kaya, & Demir (2022) in their meta-analysis confirmed the medium positive effect of the inquiry model on learning outcomes.

In 2021, the keywords that often appear are science education, learner, motivation, scientific attitude, implementation, inquiry, science, and others which are dominated by turquoise to yellow colors in the visual map. These themes highlight the psychological and affective dimensions of students in inquiry learning. Gillies (2020) emphasized that the Inquiry-Based Science Education (IBSE) approach encourages students to ask questions, develop hypotheses, and use more explorative scientific language. The following also presents the keywords for Inquiry Learning research to improve attitude skills in science learning based on density visualization.

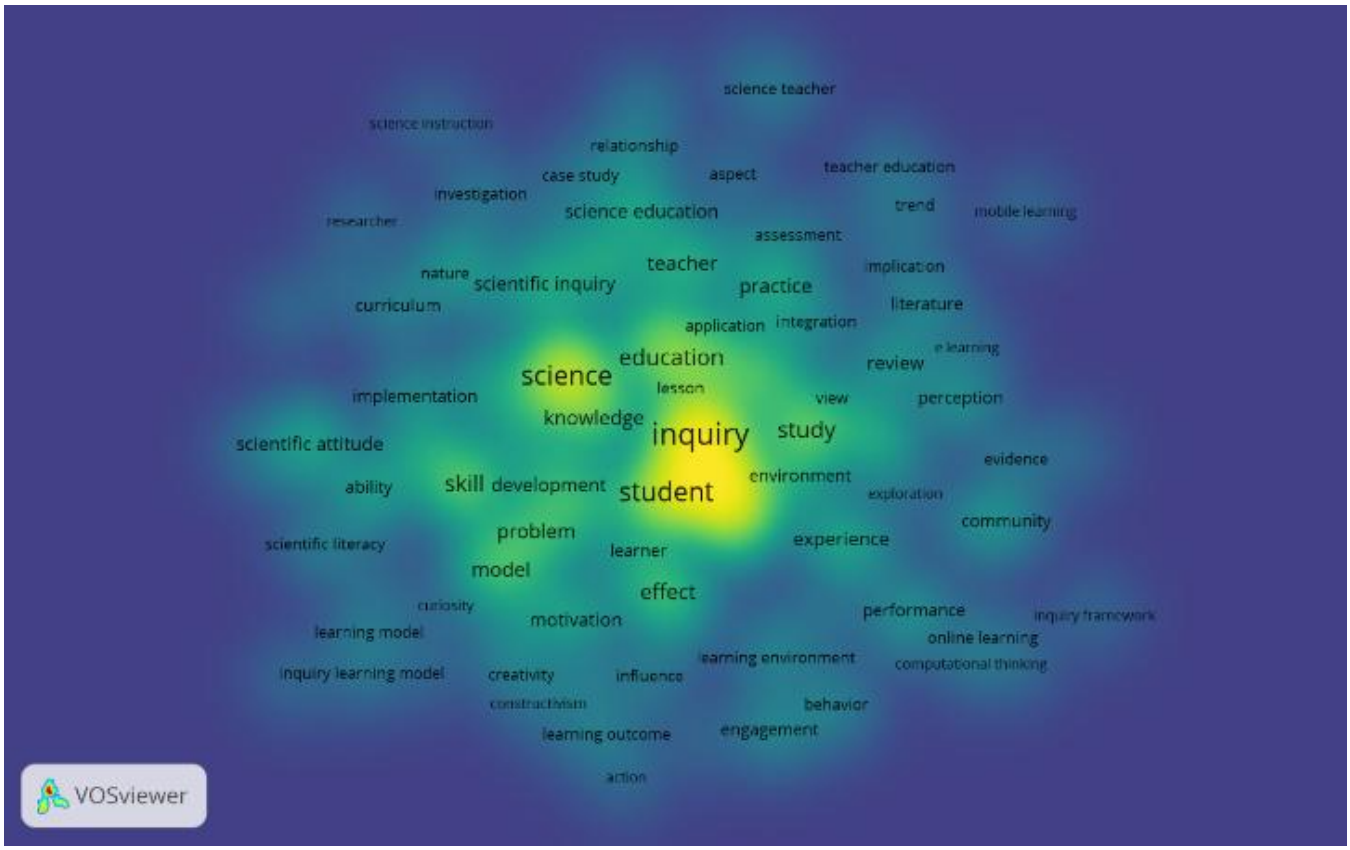

Figure 4. Density Visualization in Inquiry Learning Model to Improve Scientific Attitude Skills in Science Learning

Figure 4 shows the density visualization. The density of the research theme is indicated by bright yellow. The brighter the color of a theme, the more research is done. The fainter the color means that the theme is rarely studied (Kaur et al., 2022; Liao et al., 2018). Faded themes such as action, mobile learning, inquiry framework, researcher are dim keywords. This indicates that these keywords are rarely studied and can be used as a reference for further research. Bahtiar et al. (2023) stated that the yellow color indicates keywords that are currently and frequently used in research. Where the keywords in the image above are inquiry, student, science, lesson, education, scientific inquiry, and knowledge.

Conclusion

The development of students' scientific attitudes is a crucial aspect that cannot be ignored. Scientific attitudes include curiosity, objectivity, openness to evidence, and persistence in pursuing the truth. Based on a literature review of 1,000 scientific publications from 2020 to 2025, it is clear that the inquiry learning model, especially guided and laboratory-based ones, plays a major role in improving students' scientific attitudes. This approach encourages students to experience the scientific process directly through exploration, experimentation, and reflection, which ultimately forms a strong critical mindset and scientific attitude.

Various studies have shown that the application of inquiry learning combined with concrete media, technology integration, and socio-scientific issue-based (SSI) approaches can strengthen conceptual understanding and build students' scientific awareness as a whole. This is in line with the trend of dominant keywords in the literature, such as critical thinking skills, scientific process, and active learning, which show a close relationship between the inquiry approach and strengthening scientific character.

The distribution of the most publications in the form of journal articles also indicates the high interest and urgency of this study in the academic world. Bibliometric visualization shows that the focus of research over the past five years has been on the influence of inquiry models on students, teachers, curriculum, and technology integration in science learning. However, there are also research gaps on themes such as mobile learning and inquiry frameworks that are still rarely explored, thus opening up opportunities for further research development in the future.

Thus, the inquiry learning model is not only proven effective in improving students' scientific attitudes, but

also becomes a relevant and adaptive approach to the development of 21st century education. Therefore, this model deserves to be continuously studied, developed, and implemented widely in science learning practices at various levels of education.

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