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Students' Critical Thinking Ability in Understanding Natural Science Problems: Systematic Literature Review

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Abstract

Developing critical thinking skills in the science learning process, students are expected to have an active attitude in identifying science problems. The aim of this research is to develop learning activities on critical thinking skills in solving students' science problems. This research uses the SLR method which is carried out by: (1) identification; (2) assess; (3) interpret all existing research evidence by studying indicators; and (4) how to bring out students' critical thinking skills in science as a research object. So that this understanding can be used to solve problems and make decisions for the progress of human civilization. The conclusions in this research are: (1) differences in indicators used to measure students' critical thinking abilities; (2) differences in aspects of interpretation indicators; (3) use of PBL; and (4) STEAM approach.

Keyword: Critical thinking, science problems, Learning Based Problems, STEAM Approach, Indicator Think Critical.

INTRODUCTION

Science learning in elementary school will be very meaningful when students are able to understand the learning process. Cultivate new students' curiosity and teach them to think critically when facing problems in science lessons. In line with the opinion of (Suryawan et al., 2023) that critical thinking is an analysis and critical assessment of a problem to form a decision. Therefore, according to critical thinking, it is an analysis and critical assessment of a problem to form a decision.

Critical thinking skills in science learning are still low in Indonesia. Based on the

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explanation (Gusti Ngurah Arya Surya Wangsa et al., 2021) from the results of the PISA survey, Indonesia was ranked 62nd with an average science ability score of 403. Developments in this 5.0 era continue to occur very quickly. This situation requires someone to think critically in dealing with it. According to (Anggraeni et al., 2022) , critical thinking skills cannot be acquired instantly by students, but must be developed and accustomed to from an early age. The conclusion from these two opinions is that the ability to think critically will influence a person's success in life. This happens because, what will be done and what will be the individual's output in life are interrelated. So according to (Mulyanti et al., 2023) through learning Natural Sciences (IPA) students are able to: (1) develop analytical and deductive thinking skills using various concepts and principles; (3) identify and analyze assumptions related to science subject matter. Critical thinking skills have several indicators in learning activities. These indicators, according to research results (Adisty et al., 2021), are: (1) provide a simple explanation; (2) building basic skills; (3) conclude; (4) provide further explanation; (5) organize strategies and tactics. Based on the description of the researchers' opinions, it can be concluded that critical thinking skills are: (1) analytical skills; (3) create and use criteria objectively; (4) carry out evaluations objectively.

Critical thinking skills will increase if there are efforts to manage learning by providing opportunities for students to be actively involved in the learning process. To achieve these efforts, there must be innovation in science learning in elementary schools, for example by implementing: (1) models; (2) method; (3) renewable learning strategies or media. Thus, the focus of this research aims to analyze a comprehensive picture of students' critical thinking abilities in understanding science problems. Through content analysis of the development of definitions or indicators of critical thinking, as well as how to develop critical thinking skills in science in student learning. This is a provision for students to face problems related to nature in their lives. This research is a systematic literature review which was carried out by: (1) identifying; (2) study; (3) evaluate; and (4) interpret all existing research.

METHOD

The method used in this research is Systematic Literature Review (SLR). SLR according to (Chalkiadaki, 2018) is a method for: (1) identifying; (2) evaluate; and (3) interpret all existing research that is relevant to the problem formulation and topic area. By using the SLR method, you will be able to study and identify an article systematically in a process that follows predetermined stages.

The object of this research is indicators of critical thinking and ways to develop students' critical thinking skills in understanding science problems. In this SLR, the data found is evaluated

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based on criteria questions from quality assessment. Thus, the inclusion and exclusion criteria used in this SLR study can be seen in Table 1.

Table 1. Criteria Inclusion And Exclusion

Criteria Description
Inclusion : 1. The data used are journal articles from the last 5 (five) years from 2019-2024. 2. Data taken from accredited journals Sinta and Google Scholar 3. Data explains indicators and how to bring out or improve capabilities Critical thinking in understanding science Exceptions: 1. Data must contain indicators of critical thinking in understanding science 2. The data contains ways to develop or improve abilities students' critical thinking, namely: (a) application of problem-based learning to experiment; (b) critical thinking analysis in solving scientific critical thinking problems Science; and (c) digital products in improving critical thinking for development research.

Researchers collected journal articles from Google Scholar and SINTA. The keyword in this research is the ability to think critically to understand science problems. From the article search results, 12 articles were found with the scope of discussing Critical Thinking Skills in understanding science problems. In general, there are 3 research methods or approaches used in the 12 articles, namely: (1) 5 articles are classified as qualitative research; (2) 6 articles classified as quantitative research; and (3) 1 development article. These articles were then analyzed to find meta-analysis results related to critical thinking skills in understanding science problems to find potential for further research development.

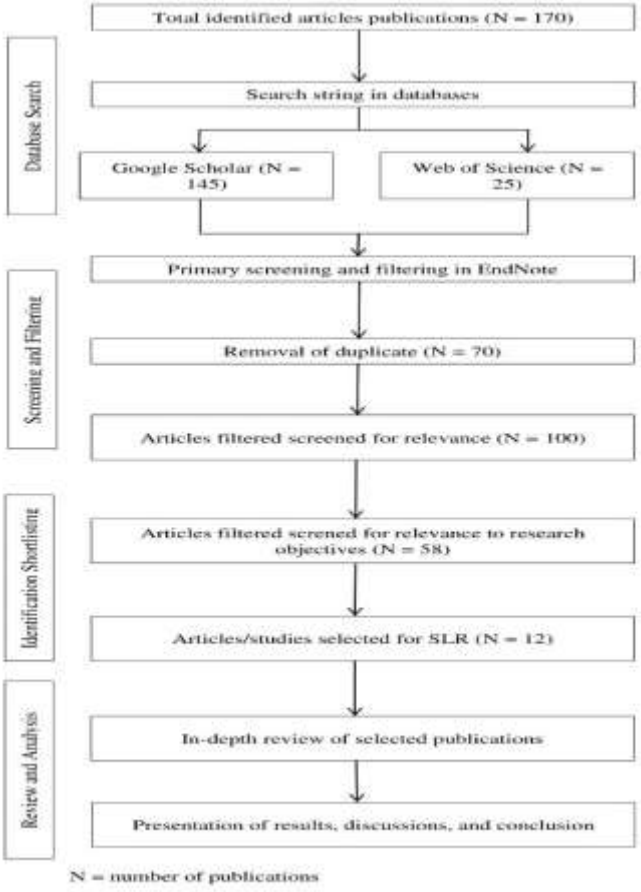
Referring to the objects and inclusion and exclusion criteria presented in Table 1 , in this study 170 articles were identified. The identified articles will go through several processes according to the PRISM graph in Figure 1.

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Picture 1. Chart PRISM Search Article

RESULTS AND DISCUSSION

Based on the results of an article search using the Publish or Perish (PoP) application with the keywords critical thinking skills in understanding elementary science, 170 articles were obtained, which then through the VosViewer application obtained visualizations and descriptions of bibliometric knowledge map exploration of these articles as in Figure 2.

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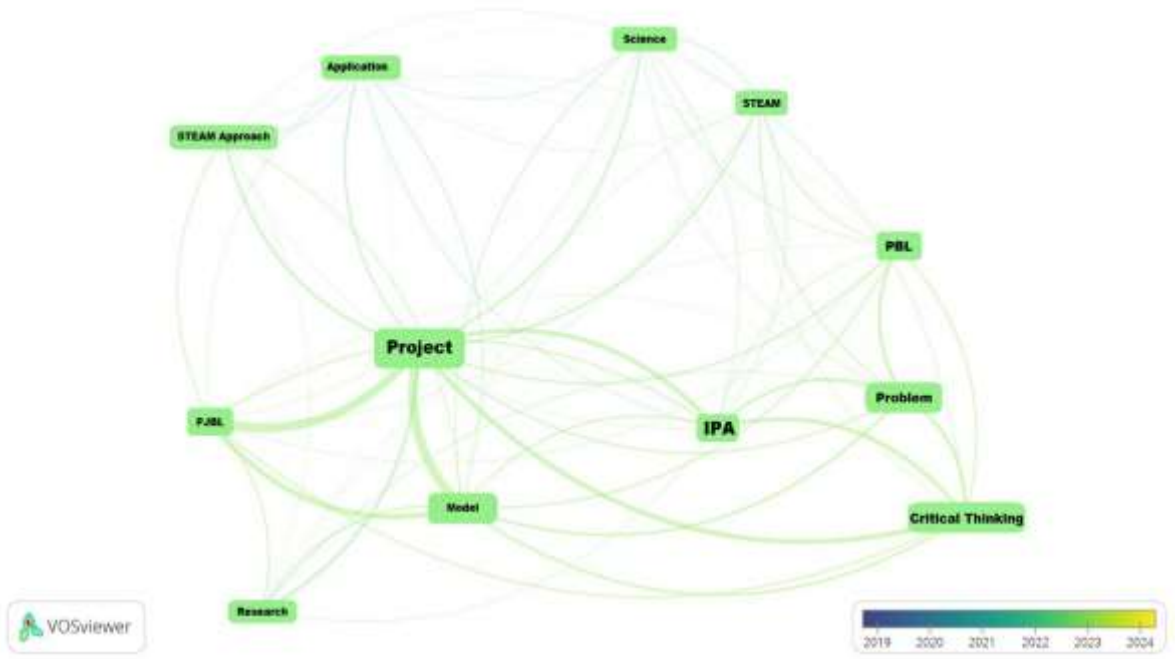


Figure 2. Visualization Study Skills Think Critical

From Figure 2 it can be seen that the study of critical thinking skills in science by understanding science problems is an interesting thing to analyze in more depth and needs to be studied further for potential research topics that can be carried out. This is very reasonable because in the last 5 (five) years little has been done, and if we discuss critical thinking it cannot be separated from problem solving as the spirit of science learning at the elementary school level. Referring to the previous Figure 1, 12 articles were obtained that were very relevant for describing the study of students' critical thinking abilities in understanding science problems, where the results of the meta-analysis of article findings are presented in Table 2.

Table 2. Meta-Results of Findings on Science Critical Thinking Concepts

No	(Author's Name, Year)	Method study	Think critical Indicator Which Used	How to Elicit Critical Thinking
1.	(Syarifuddin et al., 2022)	Qualitative research	Referring to Ennis: Use of qualitative problems to formulate: (1) problems; (2) analysis and problem solving; (3) evaluation;	Application of *Problem Based Learning*

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No	(Author's Name, Year)	Method study	Think critical Indicator Which Used	How to Elicit Critical Thinking
			and draw conclusions.	
2.	(JUWITA, 2022)	Qualitative research	Referring to Ennis: (1) analysis; (2) conclude and provide reasons; (3) evaluation; (4) and choose a solution strategy	*Best Practice* Building Science Process Skills Through the *Project Based Learning Model*
3.	(Astuti et al., 2023)	Quantitative research	Referring to Facione: (1) identification; (2) define; (3) counting; (4) analyze; (5) notes; (6) and re-examination	Steam Approach with *Problem Based Learning* (PBL) Model
4.	(Syukur & Sutrisno, 2023)	Quantitative research	Referring to Facione: (1) analysis; (2) combination; (3) evaluation; and (4) problem solving	Integrated Science Teaching Materials with Local Wisdom Insights
5.	(Cuhanazriansyah & Cahyaningrum, 2023)	Qualitative research	Referring to Facione: (1) identification; (2) define; (3) counting; (4) analyze; (5) notes; and (6) re-examination	The Role of Ethno-Steam Based Learning Media
6.	(Sapti et al., 2019)	Development research	Ennis & Weir and Facione: interpretation; analysis; evaluation; conclusion; and explanation	Development of a Science E-Module Based on *Problem Based Learning*
7.	(Fahruddin & Widiyono, 2023)	Quantitative research	Referring to Facione: (1) identification; (2) define; (3) counting; (4) analyze; (5) notes; and (6) re-examination	The Influence of the Problem Based Learning Model Assisted by Miniature

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No	(Author's Name, Year)	Method study	Think critical Indicator Which Used	How to Elicit Critical Thinking
				Water Wheels for Power Plants
8.	(Kade et al., 2023)	Qualitative research	Referring to Ennis: Use of qualitative problems to formulate: (1) problems; (2) analysis and problem solving; (3) evaluation; and draw conclusions.	Optimizing Science Literacy through Implementing STEM- *Project Based Learning*
9.	(Sappaile et al., 2023)	Qualitative research	Referring to Ennis: (1) answer questions; (2) check for accuracy; (3) analysis and clarification of questions; (4) answers and opinions; (5) evaluate and determine reliable sources; (6) argument.	Implementation of the Project Based Learning Model
10.	(Khoiri et al., 2023)	Quantitative research	Referring to Taube: (1) problem solving problems; (2) formulate conclusions; (3) calculate; and (4) make decisions	Project-Based Learning Via Traditional Games in Physics Learning
11.	(Dianita & Tiarani, 2023)	Quantitative research	Referring to Taube: (1) problem solving problems; (2) formulate conclusions; (3) calculate; and (4) make decisions	Problem Based Learning Model with Experiential Learning
12.	(Rohana et al., 2023)	Quantitative research	Referring to Taube: (1) problem solving problems; (2) formulate conclusions; (3) calculate; and (4) make decisions	Project Based Learning Model on Critical Thinking Ability Seen

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Based on Table 2, it can be seen that all research themes are related to critical thinking skills in understanding science problems. All of these articles were published in the last five years, to be precise between 2019 and 2024. From Table 2 it can be seen that the trend in critical thinking research is dominated by quantitative research and qualitative descriptive research. In addition, the discussion topics that appear in the majority of each article and the potential for further research studies can be summarized as shown in Table 3.

Table 3. Summary of Discussion Topics and Opportunities for Further Study

No	The majority of the discussion appears in the article	Analysis of Implications and Limitations	Opportunity Advanced Lessons
1.	Critical thinking indicators are guided by the opinions of Ennis and/or Facione.	92% of articles implement critical thinking indicators according to Ennis and Facione. In more detail, 48% of articles implemented Facione's critical thinking indicators and 44% implemented Ennis' critical thinking indicators. Interestingly, articles that refer to the same critical thinking indicators (implementing the Ennis and Facione indicators), have different views on aspects of these critical thinking indicators. In this case, the interpretation of one article and another regarding the indicators in question is different.	1. It is necessary to test the consistency and effectiveness of each aspect of the critical thinking indicators from Ennis and Facione's opinion. 2. It is necessary to develop indicators by modifying critical thinking indicators according to Ennis and Facione by referring to the strengths and weaknesses of the two critical thinking indicators, so that valid and reliable mathematical critical thinking indicators can be produced.

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No	The majority of the discussion appears in the article	Analysis of Implications and Limitations	Opportunity Advanced Lessons
2.	Developing Critical Thinking to understand science concepts through Problem Based Learning.	As many as 88% of articles implement problem-based learning by utilizing the following types of metacognitive problems: (1) contextual; (2) realistic; (3) authentic; (4) open; (5) unstructured. This is a starting point in learning. With problem-based learning, students will be directed to develop Higher Order Thinking Skills (HOTS) through the thinking process in solving the problems presented. A limitation of the articles presented in table 2 is that the types of questions are implemented only to motivate students to learn and make learning more meaningful for them.	It is necessary to develop and apply questions that can develop Higher Order Thinking Skills (HOTS), so that learning is not only meaningful, but can also hone students' higher order thinking skills.
3.	Developing critical mathematical thinking through implementing realistic, authentic, contextual types	As many as 48% of articles implemented contextual problem types, 8% of articles used authentic problem types, and 4% of articles implemented realistic problems. These three types of problems can construct	Efforts are needed to combine these types of problems, one of which is by combining problems: (1) contextual (2) authentic; and (3) realistic with problems that provide cognitive

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No	The majority of the discussion appears in the article	Analysis of Implications and Limitations	Opportunity Advanced Lessons
	of problems.	students towards more meaningful learning. However, the use of question types is: (1) contextual; (2) authentic; and (3) being realistic does not provide space for students to think critically ((1) analysis domain; and (2) evaluation).	conflict, for example a combination of types of contextual problems.
4.	Foster critical thinking in understanding science problems through the use of: (1) open problems; and (2) unstructured.	From all the articles reviewed, it can be seen that the percentage of using open and unstructured problem types is only 24% with 20% of them implementing open problem types and 4% implementing unstructured problem types. In principle, these three types of questions accommodate critical thinking skills (in the realm of analysis and evaluation) with differences of opinion and problem solving provided by students. However, the types of metacognitive problems that are open and unstructured do not provide space for cognitive conflicts to occur in students due to contradictions.	It is necessary to address controversial issues, namely cognitive conflict in students or can cause cognitive conflict

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No	The majority of the discussion appears in the article	Analysis of Implications and Limitations	Opportunity Advanced Lessons
5.	Foster critical thinking through the application of the STEAM approach	There are 4% of articles in the research that implement STEAM to foster students' critical thinking skills. From the 4% of articles that use STEAM, it can be seen that using the approach can provide a new atmosphere and ideas to improve critical thinking skills in the modern era. However, this article is a development of learning activities and learning instruments that cannot stand alone completely for independent learning for students.	It is necessary to develop a problem-based STEAM approach module (E-module) that can facilitate students' critical thinking in independent learning.

Of the 12 articles identified, it is known that most of the critical thinking indicators implemented refer to Ennis' opinion. Even though it refers to the same critical thinking indicator (using the Ennis indicator), there are differences or variations in aspects of the critical thinking indicator. This is due to differences in interpretation between one article and another regarding the critical thinking indicators used as a reference. Another thing that can be identified is that most of the articles that have been described use Problem Based Learning to generate critical thinking. This is in line with the opinion (Emilidha et al., 2024) that Problem Based Learning is said to be an effective model for improving students' critical thinking abilities. With problem-based learning according to (Gunartha, 2024) students will be directed to develop Higher Order Thinking Skills (HOTS) through the thinking process in solving the problems presented.

The emergence of the STEAM approach in the discussion of several journal articles also influences students' critical thinking abilities. In agreement with this, according to (Gunartha,

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2024) , the Sciences , Technology , Engineering , Art and Mathematics (STEM) approach provides more holistic, creative and integrated learning, allowing students to see the interrelationships between various fields of science and apply them in problem solving. real world so that it can improve critical thinking skills in elementary school students. It is hoped that this will prepare students to face challenges in the era of globalization which is increasingly complex and continues to develop.

The article described also uses problem types: (1) open; and (2) unstructured. In principle, these three types of questions accommodate critical thinking skills: (1) analytical domain; and (2) evaluation through differences of opinion and problem solving given to students. However, the types of problems that are open and metacognitive do not give students cognitive conflicts due to contradictions. Therefore, it is necessary to apply controversial issues that can cause cognitive conflict in students due to cognitive conflict.

From the results of the SLR study described in 12 articles, there are four topics that are highlighted, namely: (1) differences in indicators used to measure students' critical thinking abilities, aspects used to translate critical thinking indicators; (2) the use of PBL can bring out students' critical mathematical thinking skills, and STEAM-based learning also directs students to identify a problem and solve it together with a team during the learning process. From a theoretical perspective, the results of the SLR carried out turned out to be relevant, namely in line with the SLR results. From these two studies, it can be seen that in critical thinking, aspects of argumentation and reasoning are very important to continue to develop. Because argumentation can describe cognitive activities, while reasoning is the key to developing critical thinking abilities.

In addition to the relevant SLR comparisons, comparisons were also made with meta-analysis results. From the results of this comparison, it is known that the SLR results, which were carried out in line with the results of the meta analysis in terms of the application of the Problem Based Learning method and the STEAM approach, turned out to have a positive impact. The application of these two things has an effect on increasing students' critical thinking skills in the learning process. Learning activities are fun activities for students.

Based on a comprehensive description of critical thinking skills on students' ability to understand science problems, which uses: (1) indicators; and (2) its implications and limitations, it can be recommended for further research regarding STEAM science learning in elementary schools which is able to produce indicators of students' critical thinking abilities as an approach. whole and independent. Digitalization of learning can take the form of developing problem-based digital modules that facilitate students' cognitive conflicts which not only give rise to

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differences in views but also provide conflict in students' cognition so that students' analysis and evaluation processes develop more optimally and increase students' critical mathematical thinking.

CONCLUSION

The topic of studying critical thinking skills in understanding students' science problems includes various discussions. The aspects used to translate critical thinking indicators are different, the use of the PBL model can bring out students' critical thinking abilities. However, the majority of question types used are: (1) contextual questions; (2) authentic; (4) open which is still limited to conditioning more meaningful learning which does not facilitate cognitive conflict or conflict in students; and (5) The implementation of the STEAM approach to stimulate students' critical thinking already exists, however, its existence is still minimal and only limited to complementing learning or in other words, it has not been maximal in facilitating student learning in developing students' critical thinking.

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