The Effectiveness of Inquiry Learning Model In Chemistry Learning To Improve Students' Critical Thinking: Literature Review

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Abstract

Training students' critical thinking skills cannot be done with one-way learning because learning focuses only on the teacher. The inquiry learning model is very common for teachers because it involves students directly to conduct inquiries. This study aims to determine the influence of the inquiry learning model in chemistry learning to improve students' critical thinking. This study used the SLR (Systematic et al.) method. Data sources were obtained from articles, research journals, and electronic databases such as ERIC, Google Scholar, and Taylor & Francis. The variables used in this study are the dependent variable, namely the ability to think critically, and the independent variable, namely the inquiry learning model. Data is obtained through literature studies by capturing reputable and accredited national and international articles following the criteria studied. Twelve articles were obtained and then analyzed one by one. Each article briefly describes the results of its research. Student success with the inquiry learning model is seen from the increase in students' critical thinking skills. The study found that the inquiry learning model increased student competence, interest in learning, motivation, and critical thinking skills. The inquiry learning model can create a more active learning atmosphere to make learning more meaningful.

Keywords: *Inquiry Models, Chemistry Learning, Critical thinking*

I. Introduction

Chemistry is a discipline related to systematic efforts to understand natural phenomena, so learning chemistry is not only limited to memorizing facts and mastering concepts or principles but also a discovery process. The expected discovery in chemistry learning includes scientific discovery, which consists of observing, questioning, seeking information, associating, and communicating (1). Thus, the discovery process can improve student competence. One of the expected abilities is that students are

able to demonstrate critical thinking skills because critical thinking is an important competency that must be possessed for the future of students.

Critical thinking is the ability to think systematically to understand an idea and fact. In learning, students are required to have critical thinking skills. This is because critical thinking skills are needed in solving a problem. In addition, critical thinking skills also indirectly help students deal with various situations, not only in the context of solving chemistry problems but also in everyday life (1). One strategy to train students' critical thinking skills can be done by designing the right learning model.

The learning model is a learning strategy used in the teaching and learning process. A learning model is a plan or a pattern used as a guide in planning classroom learning (2). Chemistry learning is expected to help students learn the relationship between themselves and the surrounding nature, as well as its application in everyday life. Therefore, one of the learning models that refers to these objectives is the inquiry learning model.

The inquiry learning model is a learning approach that emphasizes the active role of students, who are directly involved in the investigation process, including formulating problems, collecting data, discussing, and communicating(3). In this context, inquiry learning emphasizes students' critical and analytical thinking skills to identify and solve problems. In addition, the inquiry model provides flexibility for students to adapt the learning approach to their own learning style and pays attention to the development of cognitive, psychomotor, and affective aspects so that learning is considered more meaningful (1)

Learning with inquiry models shows a significant effect on student learning outcomes in physics material. The researcher stated that learning with the inquiry model increases students' interest in learning, which is characterized by cooperation in groups and high curiosity, making students motivated to explore their own knowledge. The results of research say that there is an increase in learning outcomes that are better in experimental classes that use inquiry learning models compared to control classes that are taught conventionally(2). Therefore, learning with the inquiry model can be said to be effective in improving student learning outcomes.

Literature review mostly only reviews the implementation of inquiry learning. Inquiry learning has a significant impact on students' critical thinking skills in elementary school to high school students(4). Another literature review research said that the inquiry learning model made it easier for teachers to convey physics material and improve critical thinking skills in physics learning. Critical thinking skills in physics learning and is very suitable for use in the 21st century, especially during the *COVID-19* transition(5).

Based on this, researchers want to examine how the effectiveness of the inquiry learning model in learning chemistry and improving students' critical thinking skills. This study is considered important

to do because future teachers are required to be able to organize learning for their students to achieve learning achievements in the 21st century, known as 4C: critical, creative, collaborative, and communicative.n communicative.

The Inquiry learning model is also one of the relatively new learning models to be implemented. Therefore, a systematic review is needed. This systematic review only reviews articles published from 2013-2023. This research aims to examine the national diversity that represents or contributes to the application of inquiry learning models at the high school and university levels. The focus of this research is on the impact of the application of the inquiry learning model on students' critical thinking skills. Through the use of inquiry learning models, students are also expected to be more active and creative and increase their interest in learning.

II. Method

This research is a systematic literature review that raises the theme of the implementation of inquiry learning models on students' critical thinking skills. The selection of articles was carried out based on the suitability of the title with the theme of the research that the researcher *reviewed*. All relevant articles were collected and sorted according to the criteria, which were then used as data in this study. The targets in this study are national and international articles that are reputable and accredited and published online, which are included as the research population. The articles are then sorted according to the criteria studied. The data in this study are 12 (twelve) articles that have been filtered based on the search results and comparison of the criteria applied.

In this review, to get research articles on inquiry learning models, the *Google Scholar* database was used with the help of the *Publish or Perish* 7 application, the ERIC database, and the Taylor & Francis database. The data analysis used in the research includes two stages. The first stage is identification. The articles that have been collected are identified according to keywords, titles, abstracts, and topics taken by researchers. The articles were then filtered based on the author, year of publication, research objectives, instruments used, findings, discussion, advantages, and disadvantages. This stage is important to determine whether the article qualifies to be selected, reviewed, and analyzed in depth. The second stage is the eligibility and inclusion of articles, where articles are selected based on the criteria of articles with appropriate categories. The results of the analysis obtained 12 articles that were used as reviews in this study.

III. Results and Discussion

The data search was conducted by searching based on keywords. The keywords used include "Inquiry learning models," "Critical thinking," and "chemistry." The selection of articles was carried

out based on the suitability of the title with the theme of the research that the researcher will *review*, the time span of the article publication, namely the last ten years, and the publication of reputable and accredited articles. Articles found in the ERIC database were 1,162 related to the inquiry learning model. There were 1000 articles in the Google Scholar database and 19 articles from the Taylor & Francis database. However, so far, the articles that have been reviewed and selected and in accordance with the topics discussed in this *literature review are* 12 articles. The 12 articles are presented in a table that includes problem identification, variables used in the study, research design, research instruments, research results, and research shortcomings. The selected articles can be seen in the following table:

Table 1.

Journal Article Selection

No.	Author	Selected Journals	Database	Index
1.	Syahrial, Asrial, Dwi Agus Kurniawan, Rahmat Perdana, Reza Aditya Pratama	*Eurasian Journal of Education Research*	ERIC	Q3
2.	Mitarlis, Suhadi Ibnu, Sri Rahayu, Sutrisno	*European Journal of Education Research*	ERIC	Q3
3.	Ani Sutiani, Manthar Situmorang, Albinus Silalahi	*International Journal of Instruction*	ERIC	Q2
4.	Johar maknun	*International Education Studies*	ERIC	Q3
5.	Sanoe Chairam & Nutsuda Klahan	*Eurasia Journal of Mathematics, Science & Technology Education*	ERIC	Q2
6.	Melt Duran, Ilbilge Dokme	*Eurasia Journal of Mathematics, Science & Technology Education*	Google Scholar	Q2
7.	Muhammad Haris Effendi Hasibuan, Ngatijo, Urip Sulistyo	*Journal of Turkish Science Education*	Google Scholar	Q2
8.	Nathalie Farah, Zalpha Ayoubi	*Journal of Education in Science, Environment and Health*	ERIC	-
9.	Sitti Nurul Qamariyah, Sri Rahayu, Fauziatul Fajaroh, Naif Mastoor Alsulami	*Journal of Science Learning*	ERIC	-
10.	Tanya Gupta, KA Burke, Akash Mehta, & Thomas J. Greenbowe	*Journal of Chemical Education*	Taylor & Francis	Q2
11.	Marisa G. Weaver, Andrey V. Samoshin, Robert B. Lewis, & Morgan J. Gainer	*Journal of Chemical Education*	ERIC	Q2
12.	Roller, Saichon Sumantakul, et.al	*Journal of Chemical Education*	ERIC	Q2

In this study, the results of the review conducted are divided into two things. Namely, the implementation of inquiry-based learning and the effect of the inquiry learning model related to increasing students' critical thinking in chemistry learning. Twelve articles were selected by analyzing the initial steps in the introduction to find out the literature and plans used in journal articles. The following are the results of articles that have been reviewed and studied in this study.

Tabel 2.

Implementation of the Inquiry Learning Model

Researcher	Results
Muhammad Haris Effendi Hasibuan, Ngatijo, Urip Sulistyo	Inquiry-based learning can improve student competence
Sanoe Chairam & Nutsuda Klahan	The research findings show significant differences in the understanding of students tested through diagnostic tests on chemical kinetics material.
Dwi Agus Kurniawan, Rahmat Perdana, Reza Aditya Pratama	Increase students' learning motivation and critical thinking
Johar maknun	The application of the guided inquiry learning model improves vocational students' understanding of static fluid concepts and critical thinking.
Roller, Saichon Sumantakul, et.al	Improve understanding of lab material with an inquiry-based laboratory approach.

Based on the explanation from Table 2 regarding the implementation of the inquiry learning model in chemistry learning, it can be said that the model has been effective for use in learning activities. The use of inquiry learning can improve student learning outcomes applied by teachers (6). However, the results of the study revealed that the majority of chemistry teachers still use conventional strategies. This is because the application of inquiry learning is still considered difficult by chemistry teachers. However, the application of this inquiry model has a huge impact on increasing student competence.

Research suggests that student understanding increases with the use of inquiry learning. It can be seen from the findings that there is significant student progress in drawing a list of concepts, asking scientific questions, identifying variables, designing experiments, presenting data, and analyzing results (7). In addition, the study also found that students became more active with the application of inquiry learning models. Research proves that learning with an inquiry model assisted by an ethnoconstructivism module can improve students' critical thinking. Research conducted using control and experimental groups showed that students in the experimental group were superior in their level of critical thinking(8). The instrument used to measure students' critical thinking was the OHRCT developed by Oliver-Hoyo (2003), which has six indicators, namely abstract, report organization, information sources, report content, relevance of ideas, and presentation.

Research on critical thinking was also conducted, which showed that the average critical thinking ability of students with guided inquiry learning was higher than that of students who received

conventional learning (9). Classes taught with the inquiry learning model can design their own observation and discovery activities where the teacher only supervises. However, in the class, students still need help from the teacher in designing observation activities.

Tabel 3.
Implementation of Inquiry Model in Chemistry Learning Towards Students' Critical Thinking

Researcher	Results
Sitti Nurul Qamariyah, Sri Rahayu, Fauziatul Fajaroh, Naif Mastoor Alsulami	Inquiry-based learning in the context of SSI can improve students' critical thinking skills in introductory chemistry courses.
Nathalie Farah, Zalpha Ayoubi	The application of the inquiry and reflection (I&R) learning model is proven to improve students' critical thinking skills, especially analysis and interpretation skills.
Ani Sutiani, Manthar Situmorang, Albinus Silalahi	The application of inquiry learning models and science literacy in chemical kinetics courses provides student learning motivation and improves student critical thinking.
Mitarlis, Suhadi Ibnu, Sri Rahayu, Sutrisno	With the application of the New-Inquiry Learning (NIBL) model in organic chemistry courses, there is a significant increase in students' CACP thinking skills.
Tanya Gupta, KA Burke, Akash Mehta, & Thomas J. Greenbowe	Inquiry-based learning with the SWH laboratory instruction approach provides statistically significant differences for various critical thinking traits in students' lab reports.
Melt Duran, Ilbilge Dokme	The results of the study suggest that learning with an inquiry approach has a significant effect on students' critical thinking skills.
Marisa G. Weaver, Andrey V. Samoshin, Robert B. Lewis, & Morgan J. Gainer MorganGainer	Analysis skills in an inquiry-based organic chemistry laboratory can improve students' critical thinking skills.

Based on Table 3 above, it can be seen that the results of research on learning with the inquiry model have an effect on increasing students' critical thinking. The results of the application of inquiry learning with a Socio-Scientific context improve critical thinking skills (10). The research used a quasi-experimental method, where the research was designed with a pretest and posttest given to the control group and experimental group. Inquiry-based learning with SSI context affects students' HOTS in the experimental class. The increase was also due to the high contribution of students in learning activities. Students become more active in understanding concepts by analyzing and evaluating various sources and facts to link them to understanding.

The results of the study revealed that there was an increase in critical thinking in classes that applied the inquiry learning model (11). Measurement of critical thinking skills by comparing two groups, namely the control group and the experimental group. In his research, the critical thinking test is in the form of questions with a total of 25 questions covering analysis, interpretation, and argumentation skills. Analysis skills have levels that range from 0 to 5. Where 0 is the lowest level,

and 5 is the highest level. The results showed that most of the experimental group students' analysis skills fell into the higher-level category, while the control group students' analysis skills fell into the low category. In interpretation and argumentation, the experimental group fell into the high category, while the control group fell into the low category. The positive impact of the inquiry and reflection model is to accustom students to analyze the data and results they find themselves.

The inquiry learning model with science literacy greatly affects students' critical thinking skills in chemistry(3). The learning model developed in this study combines inquiry learning with science literacy and has the following characteristics: (1) Orientation and content explanation are carried out through stimulation of problem formulation based on the structure of learning materials, (2) conceptualization is designed through the stages of questioning and hypothesizing based on real problems in everyday life, (3) The inquiry process is to test hypotheses with stages of exploration, experimentation, and data interpretation so as to produce new knowledge, (4) the conclusion stage is a decision-making process to form hypothesis testing explanations oriented to the formation of attitudes and environmental awareness, and (5) Decontextualization and recontextualization are stages of analysis of the inquiry process through communication and reflection. Based on this, inquiry learning with science literacy was found to be effective in developing critical thinking skills. In addition, this study also found that the inquiry learning model increases students' independent learning interest, and students become more active and can solve problems.

Comprehensive HOTS or integrated multiple-HOTS consisting of CACP thinking skills. The quality of the application of the NIBL learning model to improve CACP thinking skills in organic chemistry learning classes on the topic of carbohydrates, proteins, lipids, and natural materials is seen to be in the good and very good categories. These results indicate that NIBL is a feasible and practical model. The effectiveness of NIBL in improving CACP thinking skills is shown by the N-Gain score. A significant contribution to learning outcomes is shown by the eta squared value of 0.725 for total aspects(12).

Significant differences in the critical thinking skills of experimental and control group students in terms of analysis, evaluation, inference, interpretation, explanation, and *self-organization* sub-dimensions(13). Of the four subdimensions, it can be seen that the experimental group is superior to the control group. Based on the findings conducted by the researchers above, it makes that learning with the inquiry model is very effective in learning chemistry. Chemistry learning has been considered difficult by students. This proves this learning has been able to attract student interest and increase student learning motivation, which can produce better learning achievement. better learning achievement.

IV. Conclusion

Based on the results that have been reviewed, it can be concluded that the implementation of the inquiry learning model in chemistry learning has a significant impact on critical thinking skills. Inquiry learning strategy is an activity carried out by students by emphasizing the critical thinking process in the form of searching and finding answers to the problems faced. The inquiry learning strategy can train students to develop a critical thinking mindset. In its application, it is also necessary to prepare in managing time and learning support tools so that the results are maximized.

Based on the consideration of the advantages and disadvantages of the inquiry learning model. This model is very interesting to implement and also effective in improving students' critical thinking skills in learning chemistry. However, this learning model needs to be modified by adding stages that help students think critically. For example, by inviting students to implement chemical materials in everyday life, analyzing chemical materials for their usefulness in everyday life, and the implementation of chemical materials in technology and the environment.

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