

CRITICAL THINKING SKILLS PROFILE OF SENIOR HIGH SCHOOL STUDENTS IN LEARNING CHEMISTRY

Miterianifa^{1*}, Ashadi², Sulisty Saputro³, Suciati⁴

^{1,4}Natural Science Education Department, Universitas Sebelas Maret, Indonesia; ^{2,3}Chemistry Education Department, Universitas Sebelas Maret, Indonesia.

Email: ^{1*} miterianifa@students.uns.ac.id, ²ashadiuns2014@gmail.com, ³sulisty1968@yahoo.com, ⁴suciati.sudarisman@yahoo.com

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Abstract

Purpose of the study: This current study aims to analyze students' critical thinking skills in learning chemistry specifically colloidal concept.

Methodology: The research method used in this research is mixed-method by using explanatory sequential design. Data collection techniques used interviews, observation, and essay tests that have been developed based on critical thinking indicators by Ennis. This research is based on tests and interviews of students of class XI IPA in Pekanbaru. Quantitative data analysis techniques used a pre-experimental research design with one group pretest-posttest design and qualitative data analysis techniques used interviews and observation.

Main Findings: Through essay tests, the average pre-test score was 30.15 and the post-test score was 50.67. The results provide information about high school students' critical thinking skills about the concept of colloids which are still low so that alternative learning strategies are needed to improve students' critical thinking skills in chemistry learning.

Applications of this study: The results of the research, expected to provide an overview for teachers and researchers about the condition of critical thinking skills of high school students in chemistry learning, specifically the concept of colloids.

Novelty/Originality of this study: In this research, the novelty is the development of five indicators of critical thinking skills, the results of qualitative and quantitative analysis of students' critical thinking skills on colloidal concepts.

Keywords: *Critical Thinking Skills, Learning Chemistry, Colloidal, Mix Method, Senior High School.*

INTRODUCTION

Education changes in the 21st century require a pattern of transformation in learning activities, especially the demand for activity and participation of students. Changes in education through learning are the shiftings of learning centered on the teacher (teacher-centered learning) becomes centered on the learner (student-centered learning), from one direction towards interactive, from isolation towards the environment of networking, from the passive to the active probe, from the abstract to the context, from the personal to team-based, from the factual to the critical thinking, as well as from the transmission of knowledge to the exchange of knowledge (Živković, 2016; Saleh, 2019; Changwong, Sukkamart, & Sisan, 2018). Rotherham and Willingham noted that student success depends on the skills of 21st-century skills which include: critical thinking skills, problem-solving, communication, and collaboration (Rotherham, 2017).

Partnership for 21st Century Skills as one of the life skills students need to have in the 21st century is the critical thinking skills (Lai, 2011; Olsen, 2003). The development of critical thinking skills in the student has become the main concern and goal of education in the world in the last few decades (Larsson, 2017). Because critical thinking is effective in solving various solving problems, it is related to the field of and the problems they will encounter in their daily lives. In line with the research, Gueldenzoph and Snyder stated that critical thinking is important because a person's critical thinking will automatically be able to complete simple or complex issues in everyday life (Snyder & Snyder, 2008). Based on the research of Duron, Limbach, and Waugh through critical thinking skills in the classroom, students get a pleasant learning experience, for students and teachers (Duron, Limbach, & Waugh, 2006). The learning process should implement activities that can train students' critical thinking skills to give students a chance to hone critical thinking skills (Chukwuyenum, 2013; Švecová, Rumanová, & Pavlovičová, 2014).

Critical thinking skills become an important component in classroom learning activities (Dumitru, 2012) and have the benefits of ease of life and support students in learning skills and membership empowering students to contribute actively and creatively in their daily lives (Aizikovitsh-Udi & Cheng, 2015). Empowerment of Thinking Critical thinking is very important because it can affect students' cognitive learning outcomes (Cano, 1991). However, students' critical thinking habits have not yet become a tradition in schools. According to Snyder & Snyder (2008), critical criticism is about abilities that must be developed, practiced, and continuously supported in the curriculum to support students in active learning that involves students who are developing, synthesizing and seeking information to correct problems and make them available hone students' critical thinking skills. Besides that, Paul & Nosich (Inch, 2006) suggested that developing students' critical thinking skills are needed at the present time because someone who has the ability to think critically can avoid making wrong decisions or problem-solving. With the ability to think critically, students will be easy to process the information they find and use it to solve problems.

LITERATURE REVIEW

The development of critical thinking skills in the student has become a major concern and educational goal in the world in the last few decades ([Larsson, 2017](#)). In line with the opinion of [Visande \(2014\)](#) the development of critical thinking skills about the very important role in student education and is needed by students ([de Bie, Wilhelm, & van der Meij, 2015](#); [Visande, 2014](#)) and it must also be the aim of teacher learning in all fields of science ([Thompson, 2011](#)).

Critical thinking skill is reflective and reasonable thinking based on the final decision is right or wrong ([An, 2006](#)). Critical thinking is embedded in the instruction of various disciplines and faculty which can manipulate focus-based programs so that more students thinking skills [Thomas \(2011\)](#). Proposes critical thinking skills can and must be developed and started from the first of year university level so that students can overcome future studies and be the most beneficial for entrepreneurs in the future.

So that students are prepared to compete and survive in the area of industrial revolution 4.0, education should focus on developing student critical thinking skills. With these skills, students will be ready to work together, think critically, and analytically, communicate effectively, and solve problems efficiently in various situations ([Özkahraman, 2011](#)). Such activities require students to engage in active learning, engage in high-level problem-solving skills and can participate in team activities ([Gürses, Açıkıldız, Doğar, & Sözbilir, 2007](#); [Lai, 2011](#); [Masek & Yamin, 2012](#)). Problem-solving is considered to be a mental activity that leads to the acquirement of new knowledge and skills ([Yuan, Kunaviktikul, Klunklin, & Williams, 2008](#)) One branch of Natural Science subjects is Chemistry lessons. The concepts in learning chemistry are not easily understood if the underlying concepts are not understood by students ([Ayas & Demirbas, 1997](#); [Nicoll, 2001](#)). This lesson covers a wide range of issues which, if properly stimulated, can trigger critical thinking skills of students, such as the concept Colloidal Systems. The characteristics of this concept are mostly concepts that many applications in everyday life, according to Ministry of Education and Culture Regulation number 24 in 2016 on basic competencies that must be owned by the students on the concept colloidal system that classifies the various types of colloidal system, and describes the use of colloidal in everyday life by properties and make food or other products in the form of a colloidal or colloidal involve principles ([Permendikbud Nomor 24 Tahun, 2016](#)). This research is the result of an initial observation aimed to analyze the critical thinking skills of the student in the colloidal concept in Pekanbaru city high school. In the study, the researcher uses questions that have been developing based on indicators of Ennis's critical thinking skills. Indicators of critical thinking skills developed by Ennis which distinguished five aspects of critical thinking: (1) Elementary clarification; (2) The basis for decisions; (3) Inference; (4) Advances Clarification; (5) Supposition and Integration ([Ennis, 2011](#)). The indicator of critical thinking skills developed by Ennis distinguished five aspects of critical thinking.

METHODOLOGY

The research method in this research is mixed methods with a sequential explanatory design that combines quantitative with qualitative research methods in sequence, in which the first stage uses methods of quantitative and qualitative methods in the second phase ([Sugiyono, 2013](#)). The application of sequential explanatory design is started from the collection and analysis of quantitative data followed by qualitative data collection and analysis that builds on the initial results of the quantitative data ([Creswel, 2013](#)). Overview sequential explanatory research design by Creswell as follows:

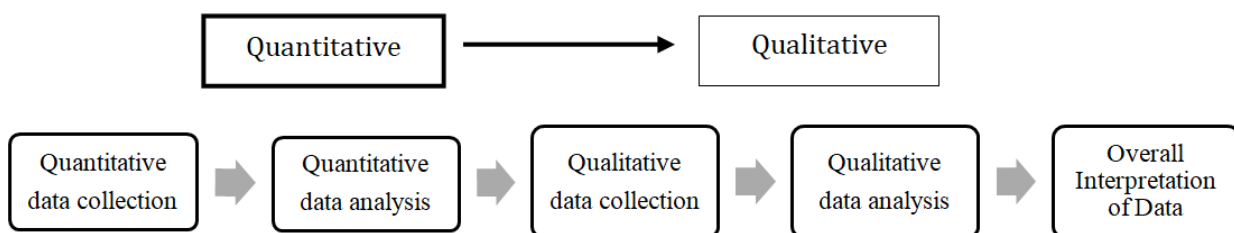


Figure 1: Sequential Explanatory Research Design ([Creswel, 2013](#))

Priority is being given to the method of quantitative data. While the use of quantitative methods to obtain descriptive quantitative data, the qualitative methods are to prove, deepen, and add quantitative data. Quantitative methods are used to obtain data on the critical thinking skills of the student through the provision in the form of essay tests before and after learning through the provision of a pre-test and post-test. Qualitative methods are used to obtain in-depth data about the critical thinking skills of learners in the chemistry learning process. The quantitative research design used is quasi-experiment with design as one group pre and post-test without control group design (see Table 1) ([Fraenkel, 2007](#)). The qualitative research design used is descriptive qualitative which intends to analyze the critical thinking skills of the student through student answer sheets.

Table 1: One Group Pre and Post-test Design (Fraenkel, 2007)

Pre-test	Treatment	Post-test
O	X	O

Note; X; Treatment by using the conventional method

Data sample sources are selected by purposive sampling in which the subject is determined before the study researched educators and learners in class XI SMA Negeri 2 Pekanbaru as many as 32 people.

RESULTS

Students Critical Thinking Skills

Based on the result of the test analysis, data showed that the average critical thinking ability of the student is still relatively low. The average yield for each aspect of indicators of students' critical thinking skills can be seen in Table 2 and Figure 2:

Table 2: Results Indicators Data Analysis Critical Thinking Skills

Sub Critical Thinking Skills Indicators	Average Indicator	Sub Category Indicator	Sub
Answering questions of clarification	52.15	Low	
Consider whether the source can be trusted or not	56	Low	
Make deductions and Consider the results of deduction	44.17	Low	
identify Assumptions	55.15	Low	
Decides an action	50.83	Low	
Average	51.66	Low	

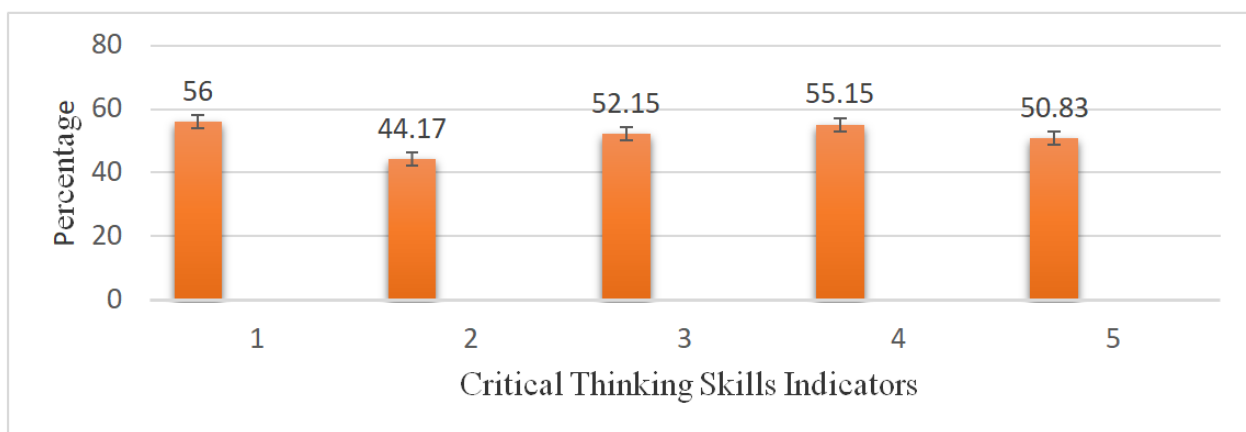


Figure 2: Percentage of students' Critical Thinking Skills 1: Answering the question of clarification; 2: Consider whether the source can be trusted or not; 3: Make deductions and consider the results of deduction; 4: Identify assumptions; 5: Decides an action.

Based on Table 2 and Figure 2, the results of the analysis of students' critical thinking skills are low. The highest achievement indicators contained in considering whether the source can be trusted or not and the lowest for the indicator Make deductions and Consider the results of deduction.

Pretest-Posttest Analysis and N-gain

The results of research conducted pretest and post-test data can be seen in Table 3:

Table 3: Recapitulation Results in Pretest-Posttest

Score	amount	Score			
		Score Ideal	The minimum value	The maximum value	Average
Pretest	32	100	20.15	42.15	30.15
Posttest	32	100	25.15	63.25	50.67

The results of the data mean pretest, posttest, and n-gain can be seen in the bar chart in Figure 3:

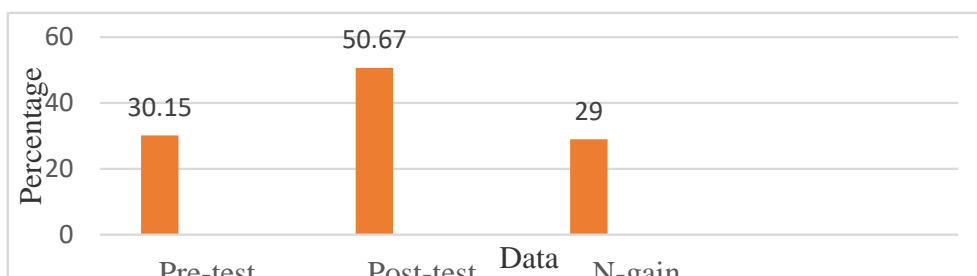


Figure 3: Percentage of Pretest, Posttest, and N Gain Score

Based on figure 3, it can be seen that overall there is an increase in indicators of critical thinking to the value of N-gain 29% in the low category. The low critical thinking skills of students are caused by the chemistry teaching methods applied that have not stimulated and fostered students' critical thinking skills. Learning chemistry tends to be teacher-centered so that students are not active in building knowledge, and do not stimulate students' reasoning thinking.

Data Results Interviews

The findings obtained from the interviews are presented in the table below:

Table 4: Students on the Current Response Answering Test Problem That Has Been Given

Question	Answer
How can you answer that question? Are you having trouble?	I can answer questions about the characteristics of colloids, solutions, and suspense. But I can not answer and solve the problem in question number b
How do you answer questions about the events related to smoke from factories and correct if the given question was really to support it or not? Do you have difficulty in answering this question?	I had difficulty in answering this question, and the question is quite difficult to predict, and also use the logic in the answer.
How do you answer the question at this water purification? And if you can make the reaction?	I'm not a complete answer because, and I find it difficult to explain the coagulation process in water purification.
Are you able to explain why gelatin is included in the colloidal system?	I only know the agar including the colloid sample but could not explain why the agar was included in the colloidal system.
Can you explain what it is norit?	I only know the functions norit, but could not explain how the norit in colloidal systems.

DISCUSSION

Answering questions of clarification

Question number 1, students are expected to be able to provide a simple explanation of a phenomenon and be able to connect phenomena related to the concepts of differentiating solutions, colloids, and suspensions. The results of one student's answer to question number 1 can be seen in the following figure:

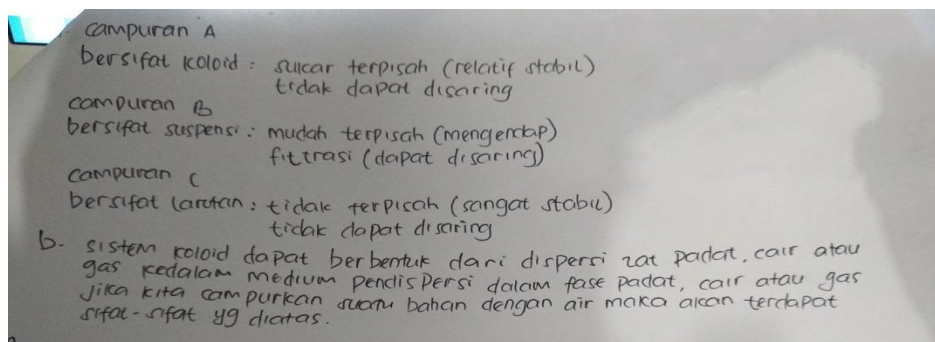


Figure 4: Questions and Answers One of the Students on Question 1

Figure 4 shows that the students can answer the question, can give a simple explanation of the difference colloids, suspensions, and solutions, but are unable to identify the mixture by applying the colloidal properties. Achievement on this indicator in the lower category, because students not accustomed to doing activities such as determining or predicting whether the students think will happen by the facts.

Consider whether the source can be trusted or not

In these sub-indicators students are given an event associated with the factory smoke. In this sub-indicator students are given an event related to the factory smoke. This question asks students to correct whether the statement given is really supportive or not and if not then the student must give the correct answer and explain it (give a reason). The answer given by one of the students can be seen in Figure 5.

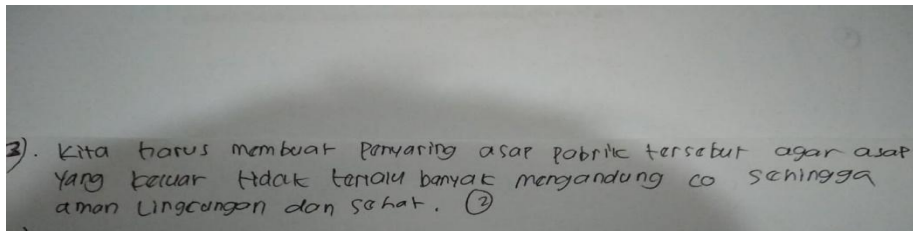


Figure 5: Questions and answers one of the students in problem number 2

If the answer to one of the students to be reviewed on a question no 2, students cannot answer the method that used to smoke good management so that the smoke coming out of the chimney is free from the CO content. Most students only answered the statement that the factory smoke can cause air pollution, smoke from factories hurt the environment, and human health.

Making Deductions and Considering Deduction Results

In a matter of loading the sub-indicators, the student should be able to declare the interpretation. Given the questions about the data, a student answering questions by making observations about water purification using coagulation. From these questions, students provide answers that will later be analyzed whether all student answers are correct or not. If the answer is not correct then the student's task is to improve the response and give the reason. Based on the students' answers on question number, it can be seen in Figure 6:

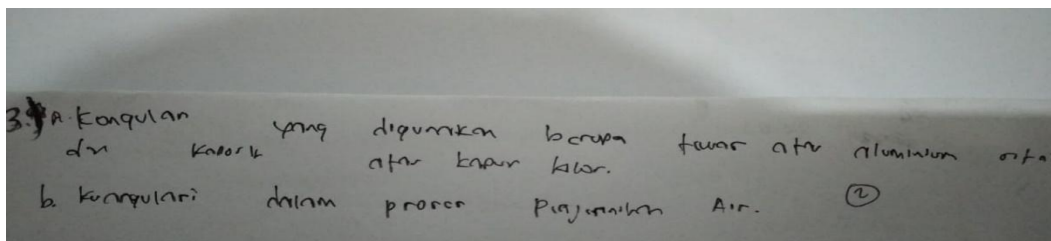


Figure 6: Questions and Answers One of the Students on Question 3

Question 3 on the average student can answer questions that have been granted a teacher, but not all correct. Students are not able to interpret the coagulation process in water purification.

Identifying assumptions

Identifying assumptions is alleged or perceived as unsubstantiated and require proof indirectly. The purpose of the sub-indicators is to reconstruct the argument in the essay test questions. In the essay test item, students are expected to reconstruct the argument about jelly that has a chewy texture found on (Question 4). The answer given by one of the students can be seen in Figure 7:

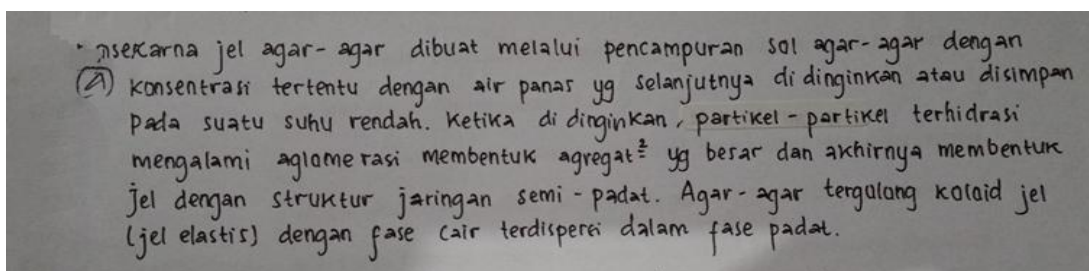


Figure 7: Questions and Answers One of the Students in Question Number 4

In question number 4, partially, the answer is the students can identify the correct answer can formulate conjectures and hypotheses, but still lacking in terms of establishing the elements necessary to draw a reasonable conclusion, Indicator identifying assumptions require direct evidence, in this case, the student has not been able to answer. Students have not been able to prove that the gelatin is included in the resulting colloid students who have never carried out laboratory work in the colloidal concept.

Decide on an Action

This indicator takes on the critical thinking ability of students resulting in this problem requires a high understanding so that students can find a strategy or tactic in answering the questions. Indicators Question 5 is to choose how to analyze the application of colloids in everyday life. Based on the students' answers on question number 5 can be seen in Figure 8:

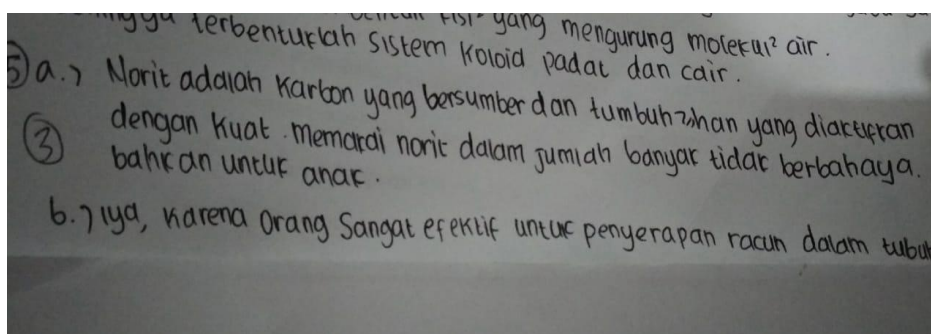


Figure 8: Questions and answers one of the students in question number 5

In question number 5 the average of student can answer questions that have been awarded the teacher. Students only know the functions norit, but could not explain how the norit in colloidal systems. Indicators decide a course of action in critical thinking is one of the very important action in critical thinking by Alex Fisher ([Johnstone, 2000](#)) because some things need to be considered in the decision that the decision taken is the right decision, namely; consider possible alternative courses of action, consideration of possible consequences in a variety of alternatives, consideration how likely or unlikely and how valuable or risk the possible consequences.

The interviews showed that some students did not understand the concept of colloids and students also often forgot about the material they had learned. This is because so far students tend to memorize in learning subject matter. Carson stated though students know the concept but not necessarily the students can find out how to apply/use it ([Meltzer, 2002](#)). Students in answering the question less attention to information that is important in the matter so that students' difficulties in predicting and also use logic in answering questions. Students' difficulties in applying the knowledge and concepts learned to solve the problem indicates that students have to practice in applying the concept or knowledge they had that ability of critical thinking skills can be empowered.

CONCLUSION

Based on the result of data analysis and discussion, it can be concluded that a) the average percentage of students' critical thinking skills was 51.66 with a low category. Results of the indicator analysis obtained for answered questions for clarification and challenging is 52.15 in the low category, consider whether the source is reliable or not is 56% lower categories, indicators make deductions and consider the results of the deduction is 44.17% in lower categories, indicators identifying assumptions 55.15% category low, an indicator to decide a course of action 50.83% in lower categories. b) the pre-test score average was 30.15 and the post-test score was 50.67 and the value of N-gain 29% in the low category, c) The results of this study provide an overview of teachers and researchers about the condition of critical thinking skills of high school students in learning chemistry, especially colloidal concept, d) Data results interviews from students on the current response answering test problem that has been given.

LIMITATION AND STUDY FORWARD

This research is limited to the colloidal concept for the SMA / MA level in Indonesia. The study provides an overview of the teachers and researchers about the condition of the critical thinking skills of high school students on chemistry learning, particularly colloidal concept. Teachers need to be more creative in designing and developing learning tools that can improve students' critical thinking skills so that it becomes a habit.

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AUTHORS CONTRIBUTION

In this research, Miterianifa contributed to the writing of the manuscript design, instrument taking data, and implementation of the research. Ashadi conceived of the presented idea. Sulisty supervised the findings and discussed the result and commented on the manuscript. Suciati contributed to develop the theory and analysis of data.

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