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# Correlation of The Implementation of The Scientific Approach with Critical Thinking and Problem Solving Skills of Students on Benzene Material

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**A B S T R A C T**

The 2013 curriculum demands the use of a scientific approach in the learning process. Based on the questionnaire distributed to 10 chemistry teachers in Padang City, it was found that the scientific approach had not been implemented, and students' critical thinking and problem solving skills were still low. The purpose of this research is to describe the correlation of scientific approach with critical thinking and problem solving skills. This type of research is descriptive research with simple random sampling technique. The study was conducted on 33 students in one high school in Padang City. The instruments used are document analysis sheets to see the completeness of teacher documents, observation sheets to see the implementation of the scientific approach, Structured Essay Diagnostic Test of Chemistry (SEDToC) to measure students' critical thinking and problem solving skills on benzene material. The results of the study indicate that the planning prepared by the teacher through the lesson plans has been implemented, but the implementation has not been carried out according to the scientific approach. After learning with a scientific approach, the SEDToC instrument was then given to measure students' critical thinking and problem solving skills. As many as 69% of students are classified as uncritical, 13% are quite critical, 18 are less critical and no students are classified as critical. While the problem solving ability of students is 100% low. The correlation test shows that the implementation of the scientific approach has a positive correlation with students' critical thinking and problem solving abilities.

## 1. Introduction

The curriculum is a set of plans and rules regarding the content, objectives, and teaching materials as well as the methods used as guidelines in the activities of the

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learning process. The curriculum is structured to realize the goals of national education by taking into account the stages of student development (Kemendikbud, 2020). The curriculum used in the Indonesian education system is the 2013 curriculum. The 2013 curriculum is a competency-based curriculum that contains an authentic learning and assessment process for the achievement of knowledge, attitude, and skill competencies. In the 2013 curriculum the orientation that will be produced is students who are creative, innovative, productive and effective with skills, attitudes, and knowledge (Majid, 2014). In Permendikbud No. 103, 2016 it is said that to improve the quality of knowledge, skills and attitudes of students, the curriculum needs to apply a learning approach, namely a scientific approach.

The scientific approach is a learner-centered approach. The scientific approach can also be interpreted as an approach that has scientific steps in developing knowledge through the scientific method. The scientific approach has steps, namely observing, asking, reasoning, trying, and communicating or it is called 5M. However, in practice the scientific approach has not been carried out optimally by educators in accordance with the steps (Suryanto, 2018).

Based on the results of the analysis of the questionnaire distributed to 10 chemistry teachers in the city, it was stated that 100% had applied the scientific approach to the learning process, but 80% had not implemented the scientific approach optimally. This difficulty is due to the limited amount of time allocation so that the learning process is teacher-centered. This is not in accordance with the implementation of the scientific approach which should be student-centered learning process while the teacher is only a facilitator. This will also have an impact on the implementation of the scientific approach with the 5M steps because if one of the 5M steps is not achieved then this will also affect the students' 4C skills, one of which is students' critical thinking and problem solving skills (Saputri & Ridlo , 2016).

Critical thinking skills (critical thinking) and problem solving (problem solving) are one of the important skills possessed by every student (Wahyono, 2017). Critical thinking and problem solving are useful in developing the self-potential possessed by students so that students are able to understand and evaluate the information received, and the information that has been received then students are able to have in-depth information in order to make a conclusion (Darmawan, Kharismawati, Hendriana , & Purwasih, 2018). Critical thinking and problem solving if not carried out properly will have an impact on the lack of students' ability to develop their thinking power, weak analytical skills will even have an impact on student learning outcomes (Nuryanti, Zubaidah, & Diantoro, 2018).

Based on the analysis of questionnaires given to 13 chemistry teachers in Padang City, 53.8% said that the number of students who completed was between 30%-60% of the number of students on benzene material. While learning is said to be complete if the completeness of students >75% pass the minimum completeness criteria (KKM). In the 2013 curriculum, students are required to be able to analyze at the cognitive level (C4). Therefore, students need critical thinking skills

because critical thinking is the art of thinking from analyzing to creating (C4-C6) (Fisher, 2011). This is related to the chemical material, namely benzene, where students must have the ability to think critically and solve problems and be able to analyze the questions given. In the 2013 curriculum syllabus, on the benzene material, students are required to analyze the structure, nomenclature, nature and use of benzene and its derivative.

Benzene material is a material that is categorized as quite difficult for students as reported. Based on the results of the questionnaire analysis that was distributed to 80 new students, it was found that 77.5% had difficulty understanding the material of benzene and its derivatives. In the analysis of the questionnaire which was also given by the teacher, it was stated that 76.9% of the benzene material was difficult to teach. One of the instruments used to measure students' critical thinking and problem solving skills on benzene is the Structured Essay Diagnostic Test of Chemistry (SEDToC) instrument. The SEDToC instrument is used because the answers to directed questions range from simple concepts to complex concepts so that when students answer questions given by the teacher, it is easier to detect students' critical thinking and problem solving abilities from the answers given by students (Fitriza, 2020).

Based on the description above, this study aims to describe the relationship between the implementation of the scientific approach with critical thinking skills and problem solving of students on benzene material.

## 2. Methodology

The type of research used is descriptive research. The population in this study were all students of class XII in one of the high schools in Padang City. The sample in this study was 33 students of class XII MIPA 4. The sampling technique used was simple random sampling. The research instruments used were questionnaire analysis, observation sheets and SEDToC.

Document analysis is used to see the completeness of teacher documents in the form of lesson plans. The observation sheet is used to see the implementation of the scientific approach. SEDToC is used to measure students' critical thinking and problem solving skills. Then the correlation test was carried out with the implementation of the scientific approach with critical thinking and problem solving skills using the Spearman rank correlation with the SPSS application.

## 3. Results and Discussion

### *Analysis Teacher Document Completeness*

The initial step taken to see the implementation of the scientific approach is to analyze the completeness of the teacher's document in the form of a lesson plan (RPP). Document analysis was carried out to see the preparation of teacher

planning in carrying out the scientific approach. RPP is prepared in accordance with the components in Permendikbud No.103, 2016. These components are subject identity, formulation of indicators, formulation of learning objectives, selection of teaching materials, learning resources, learning media, learning methods, learning scenarios and authentic assessment designs.

Based on the results of the study, it was found that the identity of the subjects, the formulation of indicators, the formulation of learning objectives, the selection of teaching materials, learning methods, learning scenarios and authentic assessment designs were in accordance with the Permendikbud component, but there were two components that were not included in the teacher's completeness document, namely the learning resource component. and learning media. Based on the analysis that has been done, the completeness of the teacher's documents is in the good category and is in accordance with the Permendikbud reference. After analyzing the teacher's document, then an analysis of the teacher's planning in the form of lesson plans is carried out according to the scientific approach.

### *Analysis Teacher Learning Planning*

The lesson plans are prepared in the teacher's plan using the discovery learning model. The discovery learning model consists of 6 syntaxes, namely stimulus, problem identification, information collection, data processing, communication and generalization. Based on the results of data analysis, the syntax that was compiled by the teacher was in accordance with the syntax in the Minister of Education and Culture (2013). The stimulus prepared by the teacher is to display a picture of the structure of benzene and display chemical products related to benzene derivative compounds. The stimulus prepared by the teacher is in accordance with the scientific approach, because when students are asked to observe the image in front, there will be a sense of curiosity of students about what is observed (Permendikbud, 2013).

Problem identification compiled by the teacher is to identify and ask questions related to the picture displayed in front of the structure of benzene and its derivatives, the properties and uses of benzene in everyday life. Problem identification compiled by the teacher is in accordance with a scientific approach, because students are given the opportunity to identify problems and formulate them into hypotheses form (Permendikbud, 2013). Collecting information designed by the teacher is that students discuss to collect information and discuss the material on the structure of benzene and its derivatives and their uses in everyday life. This syntax is in accordance with the scientific approach, because students are asked to collect as much data as possible, both individually and in groups to answer questions or prove whether or not a hypothesis is true (Permendikbud, 2013).

The data processing designed by the teacher is to process the information obtained regarding the structure, nomenclature and uses of benzene in everyday life. This syntax is in accordance with the scientific approach, because students are asked to process the data obtained and interpret the data (Permendikbud, 2013).

At the communication stage, students are asked to communicate the results obtained regarding the structure, nomenclature of benzene and its derivatives and uses in everyday life. This stage is in accordance with the scientific approach.

The generalization that has been prepared by the teacher is that students conclude about the structure, nomenclature, properties and uses of benzene in everyday life and the teacher provides clarification on the answers concluded by students. This syntax is in accordance with the scientific approach because communicating is the process of drawing conclusions on problems that have been resolved (Permendikbud, 2013). Based on the results of the analysis of the RPP compiled by the teacher, the RPP is in accordance with the scientific approach, as evidenced by the score on the teacher's RPP is 100% in the very good category. After an analysis of the teacher's planning is carried out, then an analysis of the implementation of the scientific approach is carried out.

***The Implementation of Scientific Approach***

The implementation of a scientific approach involves process skills ranging from observing, asking, trying, reasoning and communicating (Musfiqon, 2015). The implementation of the scientific approach was analyzed using a scientific approach observation sheet. The results of the analysis showed that the observing aspect was carried out according to the scientific approach, but the questioning, trying, reasoning and communicating aspects were not carried out according to the scientific approach. This is because the four indicators are not visible during the learning process, starting from not carrying out the questioning activity based on the stimulus/observing activity so that it affects the next aspect, because the implementation of the scientific approach is a scientific method that is carried out stimulant and sequentially (Musfiqon, 2015).

The implementation of the scientific approach in observing aspects is in the very good category. The observing aspect shows that indicators have been implemented according to the scientific approach. Based on the Attachment of Permendikbud No. 103 of 2016, in the aspect of observing the activities carried out are listening, listening, reading, seeing, and watching. In the aspect of observing, the indicators implemented by the teacher are displaying the structure of benzene and displaying chemical products related to benzene derivative compounds and their uses in everyday life, while for students the indicators that are carried out are paying attention to the pictures displayed by the teacher and reading other sources.

The aspect of asking questions in its implementation is not in accordance with the scientific approach. The questioning activity is still carried out on this aspect, but the questions given are not based on the existing stimulus in the observing aspect, so the questions that arise are not in accordance with the implementation of the scientific approach. Aspects of asking questions that are not implemented will affect the next aspect, namely aspects of trying, reasoning and communicating. Because the implementation of the scientific approach is learning that is carried out sequentially and stimulants (Musfiqon, 2015).

The aspect of trying is not implemented according to the scientific approach. The trying aspect activity was not carried out because the teacher did not provide an experiment or object to be observed by students and the teacher focused on explaining the material. Meanwhile, in Permendikbud No. 103 of 2016, in the trying aspect, students should collect information from various sources such as videos, pictures, conduct experiments and observe objects.

The reasoning aspect is not implemented according to the scientific approach. Reasoning activities are still carried out but not according to a scientific approach. The teacher gives questions related to the structure of benzene as many as 6 questions, then the teacher instructs students to solve the problem. But the question is given after the teacher gives an example of naming the structure of benzene. This is not in accordance with the implementation of the scientific approach. Students should process the data obtained in the trying aspect not from the teacher's explanation.

The aspect of communicating is not carried out according to a scientific approach. Communicating activities are still carried out, namely the teacher clarifies student answers, makes reports and presents results. But not according to the implementation of the scientific approach. The teacher should clarify according to the stimulus obtained in the observing aspect, not from the teacher's explanation. Based on the results of the analysis of the five aspects of the scientific approach, it was found that the implementation of the learning carried out was not in accordance with the scientific approach. After the learning process is carried out according to a scientific approach, then a test is carried out on students' critical thinking and problem solving abilities

### *Critical Thinking Skills*

Critical thinking skills are a description of thinking that is carried out in an evaluative and reflective manner. Evaluative is a decision taken based on certain considerations, whether the decision is correct or not. While reflective, students are able to concentrate the information received to make decisions (Fisher, 2011). Critical thinking skills in this study were measured using the Structure Essay Test Diagnostic of Chemistry (SEDToC).

The criteria for critical thinking skills refer to the research conducted by Kurniasih, 2010. The criteria for the assessment are concepts and ideas, information, conclusions and points of view. Meanwhile, the assessment criteria for students' reasoning abilities are clear, accurate, relevant, fast, broad and logical. Critical thinking skills are grouped into four levels, namely critical (TKBK 3), moderately critical (TKBK2), less critical (TKBK1), not critical (TKBK 0). The results of the analysis of the level of critical thinking skills of 33 students are grouped, namely critical 0%, quite critical 13%, less critical 18%, and not critical 69% according to Figure 1.

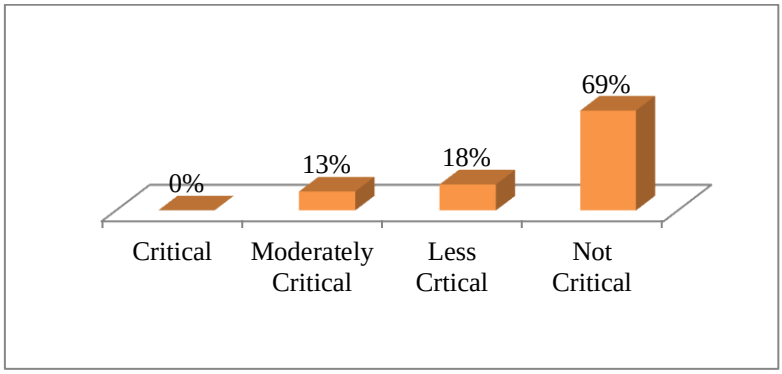


Figure 1. The Results of the Analysis of The Level of Critical Thinking Skills

Students are categorized as critical (TKBK 3) if students are able to know what steps will be described, starting from identifying problems, analyzing relationships, finding relevant concepts and solving problems with correct analogies (Kurniasih, 2010). But in this study there were no students in the TKBK 3 category. Students were categorized as TKBK 2 if students began to modify their thinking skills such as identifying problems, connecting relevant and appropriate concepts using analogy thinking to solve problems, but the insights possessed by students still limited. This is indicated by the answers of students with the initials AD.

Students have described answers such as Figure 2, students have described information, concepts and ideas as well as a fairly clear point of view. AD is able to describe 4 is monosubstitution because it has one group attached to benzene and explains that monosubstitution does not have an isomer. Problem number 5 is substituted because it has 2 groups attached to benzene and the *meta*-director will produce 1 main product and the *ortho* director, *para* produces 2 main products. Problem number 7 is polysubstitution because more than 2 groups are attached to benzene. But the answer given, the intellectual standard of deep reasoning is still limited because it does not explain the reason for question number 4 does not have isomers and in number 7 it does not provide a reason why polysubstitution has more than 2 substituents and AD's answer is not broad.

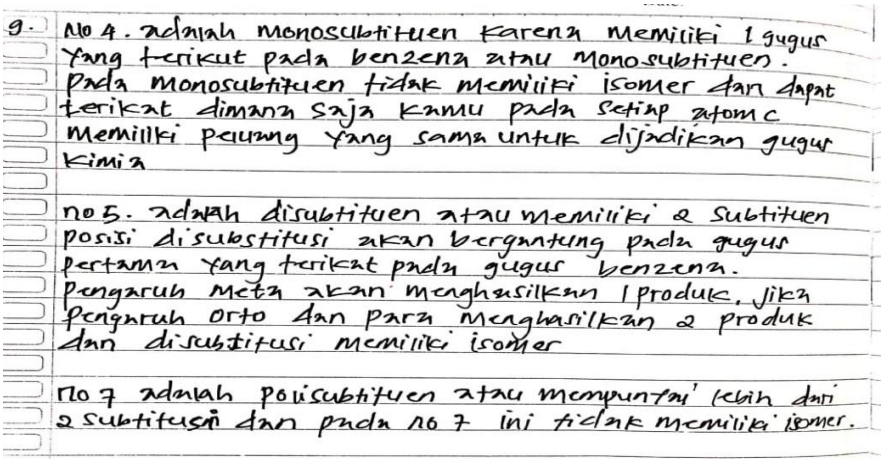


Figure 2. Answer Categorized as TKBK 2

Students are categorized as TKBK 1 if the answers given are limited to information, concepts and ideas that meet the elements of thinking. However, the ideas and concepts described are only limited in scope. This is in accordance with the answers given by the students above from the answers given by the information, the concepts and ideas of students are clear, but students have no reason why they are categorized as monosubstitution, substituted and polysubstitution. Students only categorize it.

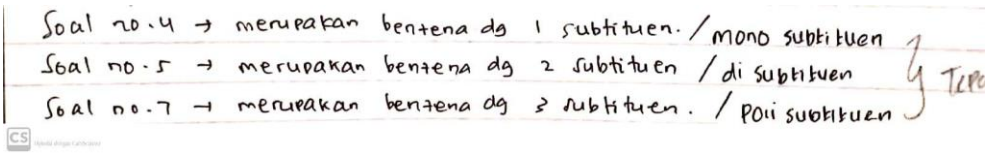


Figure 3. Answer Categorized as TKBK 1

Students are categorized as TKBK 0 as seen from Figure 3. From the answers of students the information and concepts provided are not clear, the questions are ordered to distinguish monosubstitution, substituted and polysubstitution structures, but students answer the benzene structure so that the answers given are meaningless.

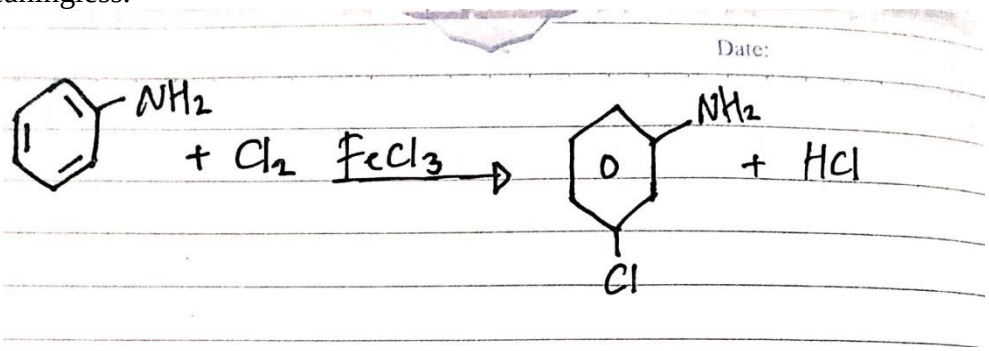


Figure 4. Answer Categorized as TKBK 0

***Problem Solving Skills***

Problem solving is a structured cognitive process that aims to train students in solving problems encountered previously empirically or systematically (Soniawati, 2022). The problem-solving abilities measured in this study were linguistic ability, schematic ability and strategic ability. Meanwhile, the ability of the algorithm is not measured because there is no calculation in the benzene material.

Based on the analysis of problem solving abilities, that 100% of students are still low. Judging from the problem-solving ability measured, the obtained linguistic ability is 42%, schematic ability is 47% and strategic ability is 0% as shown in Figure 5.

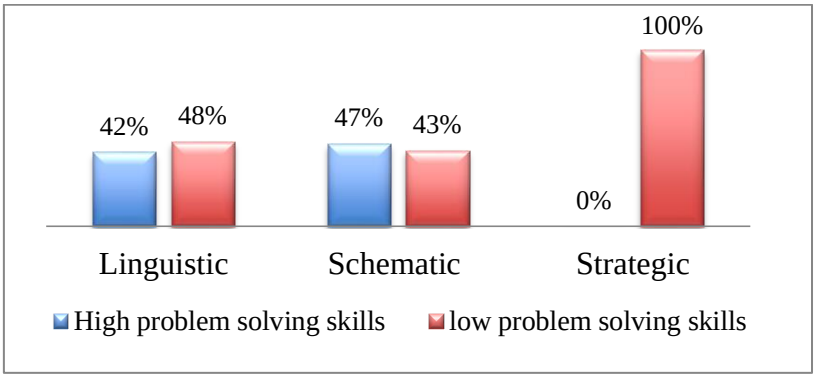


Figure 5. The Level of Problem Solving skills of Students

The problem solving ability of students is categorized as low, because students only answer linguistic abilities and schematic abilities, while in strategic abilities students do not have the ability to answer questions according to Figure 6. Based on the rubric that has been compiled linguistic ability only has a maximum score of 5, schematic ability has a maximum score of 5, while strategic ability has a maximum score of 44. This score indicates that strategic ability has the highest score. Based on the rubric of strategic ability, students are required to be able to describe protonation until a new bond is formed. But students are not able to remove protonation and do not describe the process of forming new bonds so that students' strategic ability is 0. Low linguistic ability because the source book used does not explain the steps for the formation of benzene derivative compounds, and the reaction results are immediately made. In the teacher's explanation regarding the benzene material, the steps for the formation of benzene derivative compounds were also not explained. Even though it is not explained in the source book, the teacher still explains the formation of benzene derivative compounds, so that students can understand the steps for the formation of benzene derivatives so that students do not memorize in answering questions about the structure of benzene and the expected learning competencies can also be achieved. This is because KD on benzene material is to analyze the structure, nomenclature, use of benzene and its derivatives. Meanwhile, the ability measured by KD has not been achieved.

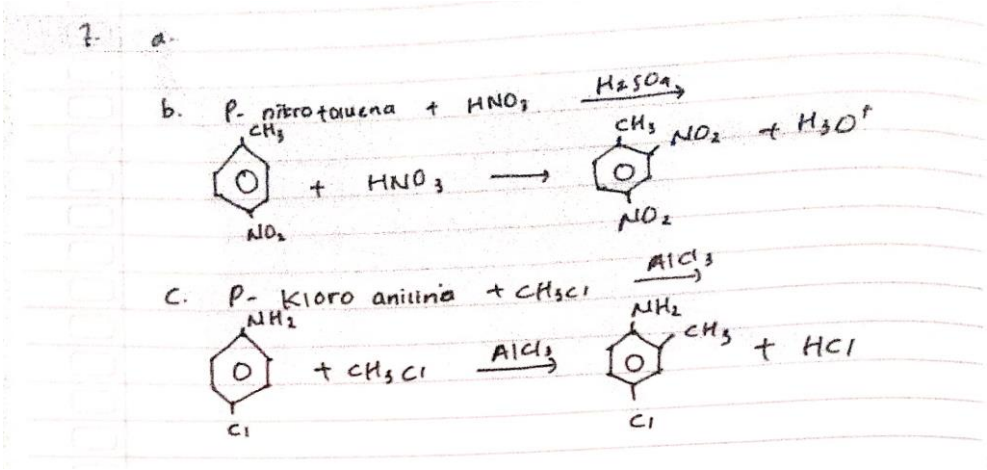


Figure 6. Students Linguistic and Schematic Skills

### *The Correlation Scientific Approach with Students Critical Thinking and Problem Solving Skills*

Implementation of the scientific approach obtained, then tested the correlation with critical thinking skills and problem solving of students. The correlation test used is Spearman rank correlation. Correlation test using SPSS application. The correlation test results obtained are correlations according to Table 1.

Table 1. Correlation Test Results

| Variable X | Variable Y | Sig. | $r_{count}$ | $r_{table}$ |
|---|---|---|---|---|
| Scientific approach | Critical Thinking | 0,011 | 0,382 | 0,344 |
| Scientific approach | Problem Solving | 0,010 | 0,437 | 0,344 |

The correlation test of the implementation of the scientific approach with critical thinking skills was obtained significantly 0.011. In this study, the significance value set was 0.05. The results obtained were 0.11 < 0.05. This shows a significant correlation between the scientific approach and critical thinking. In terms of $r_{count}$ which is compared with $r_{table}$, it is obtained that 0.382 > 0.342. This indicates a positive correlation because $r_{count}$ is greater than $r_{table}$. The correlation test of the scientific approach with problem solving skills obtained a significance of 0.010 < 0.05. This shows a significant correlation. Judging from the $r_{count}$ which is compared with the $r_{table}$, the result is 0.440 > 0.342. This shows a positive correlation between the scientific approach and problem solving skills.

From the description above, it can be concluded that the implementation of the scientific approach has a positive correlation with critical thinking skills and problem solving of students. This shows that the implementation of the scientific approach has an effect on students' critical thinking and problem solving skills. The same result was also obtained by Machin (2014) that the scientific approach played a positive role in improving student learning outcome.

## 4. Conclusion

The planning document shows that the completeness of the RPP according to what the teacher has prepared is in accordance with the scientific approach, but in its implementation it has not been implemented. After implementing the learning process with a scientific approach, the SEDToC instrument was given to measure students' critical thinking and problem solving skills. There are no critical thinking skills in 33 students. While the problem solving ability of students is still low. The results of the correlation test for the implementation of the scientific approach have a positive correlation with students' critical thinking and problem solving skills.

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