How is the improvement of critical thinking skills and student collaboration using the ICARE Model on momentum and Implus Topic?

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Abstract. The purpose of this research is to improve students' critical thinking skills and collaboration skills in learning using the ICARE model (Introduction, Connection, Application, Reflection and Extendtion). The research design used is explanatory sequential mixed method. The instruments used in the study consisted of three instruments, namely, critical thinking skills questions consisting of 11 essay-shaped questions. Collaboration skills assessment which consists of three aspects 1) Knowing one's own responsibility in the group 2) Showing mutual respect for fellow group members 3) Working as a group unit, and student response questionnaire. The participants in this study were students in one of the high schools in Lubuk Pakam city with a total of 32 students. (15 boys and 17 girls) Learning using the ICARE model is effective in training critical thinking skills with a normalized gain value of 0.56 medium category and significance at a significant level of 0.05. Learning using the ICARE model is effective in practicing collaboration skills with an average score at the first meeting of 54.43%, the second meeting of 70.73% and the third meeting of 80.73%. The conclusion of this study shows that the ICARE learning model is effective to train critical thinking skills and collaboration skills of high school students on momentum and impulse material.

Keywords: critical thinking, collaboration, ICARE model

1 Introduction

Critical thinking skills have been recognized as one of the most important thinking skills to improve student learning quality. [1][2]. Critical thinking is an active process of thinking about things more deeply for oneself, finding information within oneself rather than accepting things from others. Critical thinking skills are important to train in preparation for students to face the post-school or working world [3]. Noris states that critical thinking is able to reflect on the impact of diverse technological developments objectively and develop or choose appropriate solutions [4]. In addition to critical

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thinking, students must also be able to improve collaboration skills, because considering that in the world of work, everyone is required to be able to work in groups by collaborating. Collaboration skills show the ability to work effectively and care about diversity in groups. these skills are important for someone to survive both in the world of work and the surrounding environment. The 21st century world of work requires a person to be able to work in groups. Surviving in a group needs collaboration skills to get maximum results. So, it can be said that collaboration skills are in line with critical thinking skills.

Critical thinking and collaboration skills should be at the core of 21st century learning, learning in this century makes the classroom thinking and strategies to bring the learning process to life with quality thinking [5]. Critical thinking and collaboration skills become a picture of a person to show their abilities and knowledge. Someone who has good critical thinking and collaboration skills will show activeness in the learning process. One of the lessons that can train critical thinking skills and collaboration is physics [6]. Physics as one of the science subjects that can train and develop analytical, inductive, and deductive critical thinking skills in solving problems related to surrounding events qualitatively and can develop collaboration skills and self-confidence [7]. Thus, in the learning process, teachers should be able to train critical thinking skills and collaboration so that the physics learning process can meet the desired goals and is directly related to the teaching and learning process. Then, learning physics, it is expected that students not only have cognitive abilities but also have critical thinking skills and are able to collaborate.

Critical thinking and collaboration skills are not easy skills to implement in the classroom. In previous research, said that students' critical thinking skills when participating in learning were still relatively low and could be seen from the low initiative of students to ask questions, the lack of courage of students in expressing opinions during learning activities, the low response of students to questions submitted by the teacher, and the tendency of students' lack of independence in learning [8][9].

In previous studies, many have conducted research on improving critical thinking skills and collaboration skills. One of them the application of the problem-based learning model can improve the critical thinking skills of high school students in physics learning [10]. The results of his research show that students' critical thinking skills are still low in the evaluation category of 32 students, only 4 of whom can complete physics calculations but are unable to connect physics concepts with actual circumstances. Then on the application of project-based learning and problem-based learning in physics subjects to improve 21st century skills (4CS), stated that students still do not have high initiative in aiding other members [11].

The results of the researcher's interview with the physics teacher showed that the students' critical thinking skills were low, which was caused by the lack of student participation in group discussions seen from the rare students who gave questions and responses. The results of observations of learning activities that occur are known to be learning models that are still applied lecture method, namely the teacher presents physics material without asking questions and problems related to everyday life by providing phenomena or images that can motivate students' curiosity. In addition, the teacher does not provide opportunities for students to discuss problems in groups, this is what

makes students less involved in learning. Learning with the lecture method still occurs in many schools in Indonesia [12]. Researchers' preliminary studies that have been carried out, researchers feel the need for a learning model that is able to train students' critical thinking and collaboration skills, one of which is the ICARE model.

The ICARE model is a model that uses a constructivist approach, and the teacher becomes a facilitator [13]. The stages of the process in the ICARE learning model (Introduction, Connection, Application, Reflection and Extendtion). The ICARE model provides opportunities for students to learn more actively and purposefully based on the phases in the ICARE learning model. The learning process using the ICARE approach is expected to make students more active both in critical thinking skills and in collaboration to create a generation that can think critically and collaborate in groups according to the needs of the 21st century. In addition, with the training of critical thinking skills and collaboration, it is expected that students can understand learning concepts better than before. Figure 1 is the relationship between understanding ability, critical thinking skills and collaboration skills to the ICARE learning model.

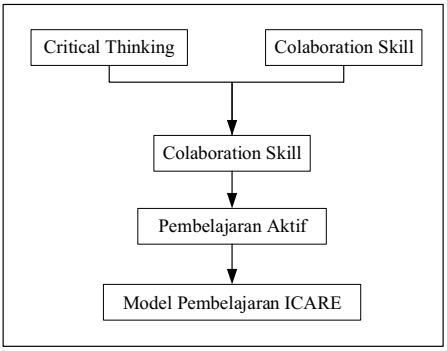


Fig. 1. Conceptual Model

2 Methodology

The research method used is mixed methods. Mixed research methods involve collecting quantitative and qualitative data, combining two forms of data, and using different designs [14]. The use of mixed research methods is done to obtain better data to answer research problems. Quantitative research methods are used to determine the improvement of critical thinking skills and student collaboration, while qualitative methods are used to determine the effectiveness of the ICARE model [15]. The research design used is explanatory sequential mixed methods [14] The explanatory sequential mixed methods design combines quantitative and qualitative research methods simultaneously. The research process with an explanatory sequential mixed methods design is depicted as in Figure 2.

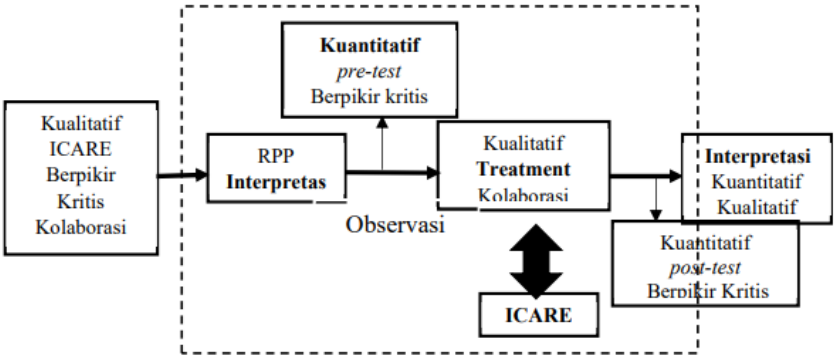


Fig. 2. Explanatory Sequential Mixed Method Design

The Explanatory Sequential Mixed Method design above is a description of the research process. At the beginning of the meeting, pre-test activities will be carried out with essay-shaped question instruments to measure the initial level of students' critical thinking after that this research is continued by assessing the level of student collaboration which is judged from the rubric for assessing student collaboration skills until at the end of this study a post-test is carried out to see the improvement of students' critical thinking skills after treatment.

2.1 Participants

The population in this study were all students of class XI MIPA in SMA Negeri 1 Lubuk Pakam Deli Serdang North Sumatra.

Fig 3. Research Location

The sample in this study consisted of one class of 32 students, namely 15 boys and 17 girls. Sampling was carried out using purposive sampling technique, which is a sampling technique with certain considerations that aim to make the data obtained later

more representative [16]. The considerations referred to in this sampling are concerned with several things, including research time, subject academic ability, and subject conditions. These things are considered so that research can be carried out effectively and efficiently.

2.2 Instrument

This test is used to measure students' critical thinking skills on momentum and impulse material. The instrument used in this research is an essay-shaped critical thinking skills test. This test was carried out twice through google form, namely at the beginning (pre-test) and at the end (post-test) of the treatment. The initial test was used to see students' initial critical thinking skills and the final test to see students' critical thinking skills after being treated. This test refers to the indicators of critical thinking skills by Ennis which consists of 5 indicators, namely (1) providing simple explanations (elementary clarification). (2) build basic skills (The basis for the decision/basic support), (3) conclude (inference), (4) provide advanced clarification, and (5) strategies and tactics. The example of research instrument to measure critical and collaborative skills on momentum and Implus material provided in Figure 4.

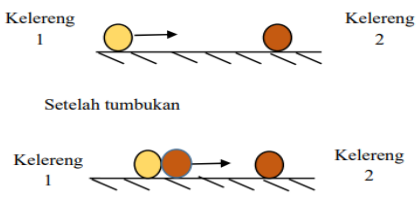
No	Aspek Keterampilan berpikir kitis	Indikator Soal	Soal
1	**Klasifikasi dasar (*elementary clarification*)** • Memformulasikan suatu pernyataan	Mengevalusi validitas data berdasarkan fenomena tumbukan	Di sore hari Dino dan Teguh memperhatikan beberapa anak kecil yang sedang bermain kelereng. Kemudian Dino berkata kepada Teguh "*ketika kelereng 1 disentil, maka kelereng tersebut menumbuk kalereng 2 yang diam. Sesaat setelah tumbukkan kelereng 1 menjadi diam. Sedangkan kelereng 2 bergerak dengan kecepatan yang hampir sama dengan kecepatan kelereng 1. Peristiwa ini dinamakan tumbukkan tidak lenting sama sekali*." Berikut gambaran peristiwa tersebut 

Fig 4. Sample Question

2.3 Data analysis

The data includes validation and reliability tests and the level of difficulty using SPSS 26. The value is more than 70% besides the Cronbach Alpha value obtained 0.88. It can be concluded that the instrument is valid and reliable to use.

3 Result and Discussion

Critical thinking skills are one of the excellent skills to measure everyone, when understanding a given problem, then critical thinking skills are excellent skills because they can think reflectively, reasonably, rationally to collect, interpret and evaluate information in order to obtain a decision. Based on the statement of critical thinking skills, this research was tested at the pretest and posttest stages. Pretest and posttest testing is the first step to find out how much critical thinking skills students have in understanding the material that has been given. Determining the level of understanding of material in critical thinking skills can be obtained using the average normalized N-Gain score <g> at the time of the pretest and posttest. The results of the study obtained data on the initial test (pretest) and the final test (posttest) of critical thinking skills. The level of improvement in comprehension skills categories [17].

Table 1. Recapitulation of pretest, posttest and normalized gain results of students' KBK

Average Score		<g>	Categoriez
Pretest	*Posttest*		
56.11	81.32	0.56	medium

Based on Table 1, shows the results of the average normalized gain for pretest and posttest scores on students' critical thinking skills, after implementing the ICARE learning model. The average score of the pretest value of students obtained was 56.11 with an expected ideal score of 100, while the postest value of students after implementing ICARE learning increased by 81.32 with an ideal score of 100.

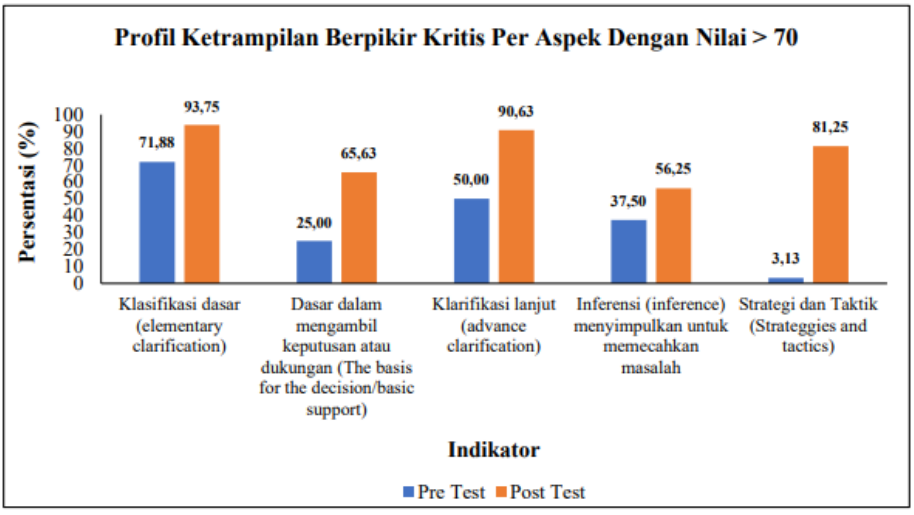


Fig. 5. Calculation results on each indicator of critical thinking skills

3.1 Improved Critical Thinking Skills

In obtaining the results of improving students' critical thinking skills, the average results of the critical thinking test instrument are taken as shown in Figure 5. This research refers to [18], including indicators of providing simple explanations (elementary clarification), building basic skills (The basis for the decision/basic support), inferring, providing advanced clarification, and strategies and tactics. The effectiveness of ICARE Model Learning on Critical Thinking Skills on momentum and impulse material can be seen from the results of the n-gain increase of 0.56 which is included in the moderate category, the student's pre-test score reached 56.11 and post-test 81.32. Students' critical thinking skills tests were given before treatment and after ICARE model treatment. From the percentage results that have been explained in the results section, the ICARE model is effective for improving students' critical thinking skills.

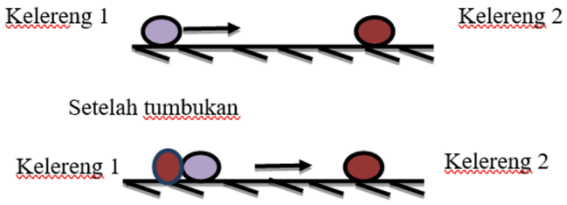
From these results, it can be concluded that the level of effectiveness of critical thinking skills on the ICARE learning model is very high or very effective. This is because in each phase of the ICARE learning model on momentum and impulse material improves students' critical thinking skills. At the Introduction stage as explained in the discussion in the learning implementation section trains students to ask and answer their friends' questions then at this stage the teacher provides stimuli so that students can practice critical thinking skills through discussions that refer to extracting initial concepts. At the Connection stage there is a question and answer between the teacher and students based on the experiences that students have experienced. Then in this section students are required to conduct experiments as concept planting activities. In the third phase or Application. The application part requires learners to solve everyday problems in unique and unusual ways. This Reflection section requires learners to be able to think both directly and indirectly. Critical thinking skills are trained when learners start making presentation tools.

Learners are required to be able to express their ideas or ideas well through presentation media. This trains critical thinking skills. Then in the last phase or extention phase the teacher directs students to conclude learning at each meeting. In addition, with the application of the ICARE model, students have more time to construct their own knowledge because the learning process is centered on students while the teacher acts as a facilitator. This is in line with previous research, where from the results of his research it was found that the ICARE model was effective for improving students' problem-solving skills. The Figure 6 is an example of a question and the results of student answers at the highest percent indicator is in elementary clarification.

Based on Figures 6, the learners can correctly reason and write the equation of the law of conservation of momentup based on the event of playing marbles. Then learners are also able to detect errors from impulse measurements. The reasons given show that learners can use their knowledge about the concept of momentum and the measurement of impulse phenomena.

Question

Di sore hari Dino dan Teguh memperhatikan beberapa anak kecil yang sedang bermain kelereng. Kemudian Dino berkata kepada Teguh "ketika kelereng 1 disentil, maka kelereng tersebut menumbuk kalereng 2 yang diam. Sesaat setelah tumbukkan kelereng 1 menjadi diam. Sedangkan kelereng 2 bergerak dengan kecepatan yang hampir sama dengan kecepatan kelereng 1. Peristiwa ini dinamakan tumbukkan tidak lenting sama sekali." Berikut gambaran peristiwa tersebut. Apakah pernyataan Dino sudah benar? Jika sudah/belum jelaskan. Tuliskan bentuk persamaan hukum kekekalan momentum dari peristiwa tersebut?



Student Answere

Soal 1

Pernyataan yang diberikan Dino salah. Dikarenakan posisi benda atau kelereng setelah tumbukan berbeda dengan posisi benda yang bertumbukan tidak lenting sama sekali. Hal ini dikarenakan ketika benda 1 bergerak dengan kecepatannya, dan menumbuk kelereng 2, sehingga menyebabkan kelereng 1 diam akan tetapi kelereng 2 bergerak dengan kecepatan yang sama dengan kelereng 1. Menurut saya tumbukan yang terjadi adalah lenting sempurna dikarenakan V2' memiliki kecepatan yang sama dengan V1, dan V1' memiliki kecepatan yang sama dengan V2. Sehingga ketika mencari koefisien restitusinya, maka didapatlah e=1.

Fig. 6. Example of Elementary Clarification Problem

3.2 Improved Collaboration Skills

In this study, the findings are about improving collaboration skills. Collaboration skills are obtained from data on ICARE learning process activities on momentum and impulse material in groups. When students carry out the learning process in which there are practicum activities according to Figure 4.34, an example of *post-test* answers on *advanced clarification* indicators with ICARE learning stages. Learners were assessed by each observer for each group using an instrument in the form of a collaboration skills rubric consisting of 3 aspects: 1) Knowing one's own and group responsibilities, 2) Showing mutual respect for fellow group members, 3) Working as a group unit. This collaboration skills rubric is an adaptation of the *P21 Framework* by the *Buck Institute for Education* [19]. Each aspect is given a score of 1, 2, 3 and 4 with the lowest skill level given a score of 1 and the highest given a score of 4. After that, the total score is obtained by adding up the scores from each aspect with a maximum score of 12. These collaboration skills are observed during the learning process by seeing the progress at

each meeting. The processing results of the assessment for each meeting obtained the following results as in Figure 7.

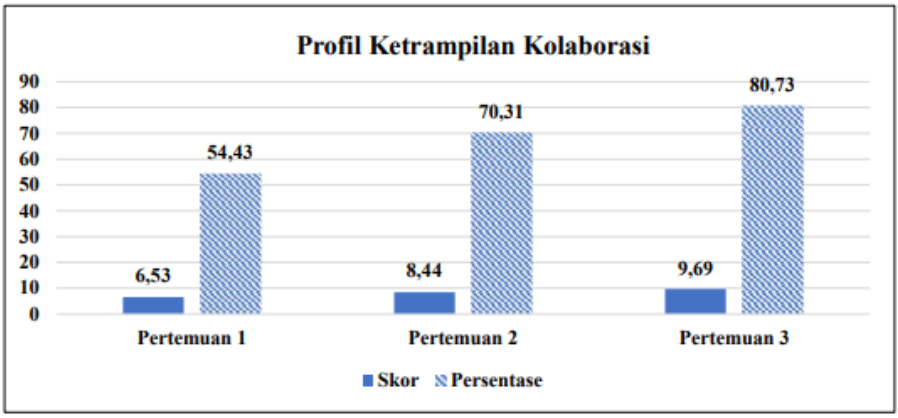


Fig. 7. Diagram of collaboration skills profile

Based on Figure 7, during the application of the ICARE model learning on collaboration skills has changed, this is indicated by the increase in the percentage profile of students' collaboration skills. At the first meeting the collaboration skills of students were included in the low category with a percentage of 53.43%, at the second meeting the percentage of collaboration skills was 70, 31% with a good category. At the third meeting the percentage of students' collaboration skills was 80.73% with a very good category. Figure 5 illustrates the profile of collaboration skills with the indicator of knowing the responsibilities of oneself and the group. During the application of the ICARE learning model.

The effectiveness of ICARE Model Learning on momentum and impulse material on collaboration skills can be seen from the involvement (activity), group cooperation response, observation results by observers and the results of working on student worksheets (LKPD). LKPD is given to students at each meeting. Then the effectiveness is seen from the results of improving aspects of collaboration skills skills at each meeting. The results obtained through observation based on student assessment questionnaires, there was an increase at each meeting. So, it can be concluded that the level of effectiveness of collaboration skills on the ICARE learning model is very effective. This is because in each phase of the ICARE learning model triggers students to collaborate. In the Connections phase, researchers have divided students into groups. Then the researcher shows a demonstration through a video. From the demonstration activity, students are asked to discuss with the group then express their opinions on the results of the group discussion based on the demonstration. The connection part lasts the longest because learners are required to conduct experiments as concept planting activities. Where this section also trains collaboration skills, learners are required to discuss in groups when conducting experiments. Learners are required to take a role in the group to gain their own concept understanding. In this section, researchers focus on each active learner in group activities as a facility for practicing collaboration skills. Then in

the Application phase at this stage the researcher pays attention to the discussion of students to ensure that students have collaborated well in solving the problems given. In the next Reflection phase, learners are given the opportunity to express the results of their group discussions directly to their friends. At this stage learners share teams with other members in presenting the results of their discussions in working on LKPD.

4 Conclusion

Based on the results of research that has been conducted on the effectiveness of ICARE learning on critical thinking skills and collaboration skills on momentum and impulse material, it is concluded that the ICARE learning model is significantly effective for improving students' critical thinking skills on momentum and impulse material. The ICARE learning model is significantly affective to improve students' collaboration skills on momentum and impulse material.

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