The Effect of Project Based Learning Model's on Critical Thinking Skills, Creative Thinking Skills, Collaboration Skills, & Communication Skills (4C) Physics in Senior High School

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ABSTRACT
This study aims to (1) determine the differences in students^ critical thinking, creative thinking, collaboration, & communication (4C) skills due to the effect of implementing project based learning (PjBL) models with conventional learning, (2) determine the improvement of students^ critical thinking, creative thinking, collaboration, & communication (4C) skills due to the application of the project based learning (PjBL) model. The type of research used in this research is quasi-experimental. The population in this study were all students of class XI MIA MAN Tapanuli Selatan T.P 2020/2021. The sampling was done by cluster random sampling by taking 2 sample classes. The instruments used in this research are test instruments in the form of descriptions for critical thinking skills and creative thinking and non-test instruments in the form of observations for validated communication and collaboration skills. The data analysis used was the Manova test for critical thinking skills and creative thinking skills, whereas the N-gain analysis was used for communication and collaboration skills. Based on the results of data analysis, it was found that the 4C skills of students taught by the PjBL model were better than the 4C skills of students taught by conventional learning. The N-gain percentage in students^ critical thinking skills are increased by 75.40% (high category), students^ creative thinking skills are increased by 90.78% (high category), students^ collaboration skills are increased by 15.37% (low category), and students^ communication skills are increased by 80% (high category).

Keywords: *Project Based Learning (PjBL)- Critical Thinking Skills- Creative Thinking Skills- Collaboration Skills- Communication Skills.*

1. INTRODUCTION

Critical thinking skills as one part of the 4C are reflective thinking skills that focus on the process of making decisions to solve existing problems (Ennis, 1996). Critical thinking skills can be achieved by innovating learning in accordance with problem-based and project-based learning activities, training in collaboration, training in communication, applying metacognition, designing learning that is closely related to reality, and is student-centered. [1][2][3].

The desired expectations have not been reflected in the facts on the ground. This can be seen from the response of most people in responding to news on social media. They are faster to comment and believe the news they have just received without analyzing the truth of the news. This does not only happen in social media, but also in the learning process. The critical nature of students when receiving information is still lacking, not investigating it first, and rushing to draw conclusions. This is in line with the researcher's teaching experience which shows that students are reluctant to make further explanations or even provide alternative answers that may arise from the problems presented by the teacher.

In addition to critical thinking, creative thinking skills are also included in the 4C skills needed in 21st century learning. Creative thinking during learning can help students develop their attitudes, motivate discovery and exploration, and support

cognitive development [4]. Scott states that the future of humanity depends on the ability to position creativity and innovation at the forefront of the education system. These abilities include problem solving, new ways of thinking, providing new ideas and solutions, asking different questions, and different answers as a form of innovation and creativity [5].

Shaheen researched that in developed countries creativity is made part of the educational curriculum and includes the main skills that must be present in students [6]. That is, creativity can be trained since childhood so that students can create original and distinctive works, but in terms of teaching physics, students are still unable to produce original works or innovate ideas so that students only express general opinions if given a problem.

The next skill is collaboration skill. Collaboration skills are an attempt to demonstrate the ability to work effectively and respect each other so that goals can be achieved with responsibility [7]. Effective work skills can be trained with collaboration to achieve goals [8]. That is, by practicing collaboration skills, students can accept differences by respecting each other and promoting the common good. Based on experience in the field as a teacher at one madrasa, there are still many students who are less productive so it is difficult to accept differences of opinion and is not responsible for their group.

The last skill of the 4C is communication. Communication skills include the ability to express thoughts clearly and persuasively, both orally and in writing, articulate opinions, communicate coherent instructions and motivate others through speech [9][10]. Effective communication skills can help avoid misunderstandings and miscommunication. These skills can be developed through the training process, having dedication, and always working hard [11]. Mahajan also continues that if communication skills are neglected, the expectations for students to be skilled in communicating are not met. This study uses communication indicators, including the adaptation of scientific communication, this is because scientific communication has specifications that are in line with the teaching of physics. The scientific communication indicators used are: getting information, reading scientifically, listening and observing, scientifically writing, and presenting information [12].

Based on this explanation, it can be concluded that communication skills have a very important role in all fields, but the reality shows that students are less attentive in finding scientific information from many sources, not looking at registered sources so that they use the internet as an unaccountable source. , does not display information in the form of graphs, tables, images, or illustrations.

The reason why students are not skilled in 4C is learning in the classroom that still emphasizes the role of the teacher as a transmitter of knowledge and students are only used as recipients of information, so students are not active in learning activities [13]. Trianto explained that such learning cannot form students' 4C skills because students complete something based on the instructions given by the teacher [14].

Based on this description, 4C skills can produce students who are ready to solve problems well and get solutions to solve these problems from various aspects. [15][16][17] also stated that students who have 4C skills will get good learning and career outcomes. One of the learning models that can produce students who have 4C skills is the Project Based Learning (PjBL) model.

The characteristics of PjBL can be achieved if the teacher carries out the learning process perfectly. The teacher's task in implementing the PjBL learning process is to provide current problems, stimulate students' thinking with questions about the problems discussed, and provide tools and materials that can be used to design projects according to the material [18]. Improve 4C skills through understanding concepts [19][20][21].

Optical instruments are the materials used in this research. Material selection is based on the achievement of basic competencies and adjusted to PjBL steps. The basic competence of knowledge is to analyze the workings of optical instruments that use the properties of reflection and refraction of light by mirrors and lenses. Students' 4C skills can be trained through learning activities.

2. METHODS

This research was conducted at MAN Tapanuli Selatan which is located at Jl. Simangambat, Ex. Bungabondar, Kec. Sipirok, South Tapanuli Regency, North Sumatra. The research population was all students of class XI MIA MAN Tapanuli Selatan T.P. 2020/2021. The sample in the study consisted of 2 classes that were randomly selected with cluster random sampling technique. This type of research includes quasi-experimental research.

The instrument used in this research is the Student's Critical Thinking Skills Instrument which uses 5 indicators in the form of an essay; Students' Creative Thinking Skills Instrument with indicators used are fluency, flexibility, originality, elaboration [22]; The instrument of collaboration skills uses observation and questionnaires; communication skills instruments, in this study using observations and questionnaires based on scientific communication indicators according to Spektor-levy, Eylon, & Scherz.

3. RESULT AND DISCUSSION

3.1. The effect of the PjBL model on students' 4C skills

This study will examine whether or not there is a significant difference between critical thinking, creative

thinking, collaboration and communication skills of students who are taught by the project based learning (PjBL) model to students who are taught by conventional learning on the material of Optical Instruments in class XI semester II. MAN Tapanuli Selatan TP 2020/2021. The manova test which was carried out on posttest data in this study, obtained results with a significance value of <0.05 (0.00 <0.05). Based on the significance value, it can be concluded that there are significant differences in critical thinking skills, creative thinking, communication, and collaboration between students who are taught using the PjBL model and students who are taught using conventional learning. The average post-test obtained based on calculations for critical thinking skills, creative thinking, communication, and collaboration in the control class were 62.43; 57.73; 58.83; and 62.40, while in the experimental class they were 70.90, respectively; 73.10; 80.57; and 71.30. Based on the results of the average post-test of the experimental class and the control class, it can be seen that there is a difference in the acquisition of the average value of the experimental class and the control class (the average posttest value in the experimental class is higher than the average posttest in the control class). This difference occurs because learning in the experimental class uses the PjBL model, namely by providing problems related to everyday life and poured into project worksheets, then students are asked to solve these problems by producing a project related to ongoing learning materials.

This study began by giving a pretest to the two sample classes, this pretest was conducted to find out whether the two sample classes had the same initial ability or not and based on the tests carried out it was found that the two samples had the same initial ability. The research can be continued because the initial abilities of the experimental class and control class are the same. The research continued with the learning process in the experimental class. Learning in the experimental class is carried out by applying a project-based learning model (PjBL). Learning begins by dividing students into 5 groups that are determined randomly in order to create cooperation, communication, and collaboration in groups. Each group is given a project worksheet containing problems related to daily life and each group is asked to think of various solutions that will be used to find the solution. Solutions will be obtained by determining the sources to be used, collecting various information related to problems and problem solving, analyzing various arguments in groups, determining problem solving and ending with formulating conclusions. Such learning can improve students' critical thinking skills.

Learning using the PjBL model can also improve students' creative thinking skills because it can train students to provide many answers to problems, generate varied ideas, be able to give birth to unique expressions, and be able to develop an idea in detail, for example when making simple loops. Some students in the group suggested using clear plastic filled with water, clear bulb filled with water, and transparent glass plastic with drops of water. Students suggest these materials because these materials can be easily found in their surroundings. The light bulb and transparent plastic filled with water will turn into a convex lens like a real lens. Based on this explanation, it can be seen that students' creative thinking skills are starting to be honed through project-based learning. Similar results were also conveyed by Ni Made, et al., in their research which states that project-based learning can train students to ask questions, think of many ways to solve problems, and find new things that other people don't think of. Setyowati & Mawardi, 2018 also stated that students who were taught using the project based learning model had better creative thinking skills than students who were taught using conventional learning.

At the initial meeting, the students were still confused about finding ideas that would be the solution to the problems presented so that more time was used, so the researchers suggested students to take advantage of the information technology available at the school at that time, namely by searching for information through a computer connected to a computer. internet network available at school. The suggestion that the researcher gives is supported by the opinion of Levin & Goldberg which also suggests that students can use technology to explore ideas [23]. Skilled in using computer and internet technology when looking for information is included in the indicators of digging information on communication skills so it can be concluded that the PjBL model can improve students' communication skills. Andri, et al also stated that by applying the PjBL model, students' communication skills will also increase. At the first meeting at this time, students still could not give an argument, still thought that the argument was the most appropriate, and still felt strange about the learning system that was running in the classroom. The obstacles felt by students during the learning process had an impact on project results that were not maximized, so this was used as material for improvement at the next meeting.

The next meeting, students are getting used to learning situations and can provide the best ideas that will be selected from several ideas based on several sources of information to be a solution to the problems given because students have used smartphones to obtain information after getting permission from the school and can help each other between groups. when experiencing difficulties in the teaching and learning process. The results obtained at this meeting showed an increase in students' communication and collaboration skills. During the learning process, differences of opinion arise between group members in solving problems, some groups can solve them themselves with communication skills based on reliable sources of information and some others need help from researchers. The explanation

illustrates that students' communication skills have increased when compared to the previous meeting. This statement is in line with the opinion of Spector-levy, et al. who wrote that involving students in retrieving information and reading scientifically can improve students' communication skills. Students' skills in finding information, analyzing arguments, and considering the sources to be used can improve students' critical thinking skills. This is supported by Sumarni who writes that the information obtained by students must be analyzed first before it is decided to be used in solving problems so that students are skilled in critical thinking [24].

At each meeting, there is a project design process. The researcher explained that each group followed the steps in the worksheet provided so that the project made could be completed within the allotted time. The researcher guides students to first make time plans in completing projects, divide tasks to all group members and make agreed deadlines to complete each task. Assignments made in detail about the project design that will be used can foster students' creative thinking skills. Keeping up with work and respecting others will also improve collaboration and communication skills between groups when designing division of labor. During the learning process, both students and researchers did not experience problems that could hinder the learning process. Students can interact well between group members which shows that students' communication skills have increased in each meeting. Students managed to make plans and deadlines well, this is evidenced by the completion of each group's project at the allotted time.

The process of drafting a project is a process that is carried out after designing the project. In this process students make an illustration (picture) of the project to be made. Researchers give students the freedom to find information related to the tools and materials used as well as a place to find tools and materials used from print and electronic media to complete the project. Each group makes a model through the pictures depicted in the project worksheet. Projects are prepared based on information and ideas that have been agreed upon based on the consideration of the criteria of the sources used. Critical thinking skills can be formed in this phase because students build basic skills by considering the criteria of a source. Each group designs its own project without looking at the other groups, so that in this process students' creative thinking skills can grow. Differences of opinion in maintaining the sources obtained by each student still exist in this process, but these differences of opinion are not used as a problem in learning but are used as a forum to train students to respect others so as to foster student collaboration skills. Communication skills also remain trained in this process, it can be seen from the way students hear, receive, and decide which information to use from various sources available to each student.

The next process is implementing the project. Not all projects are implemented during the learning process in the classroom due to time constraints in each meeting, so the project must be completed outside the classroom and continued at the next meeting. During this process, students work together to apply what has been designed to be a solution to the problem in the form of a product. In this process there are difficulties experienced by researchers, namely the lack of conducive class during learning, this happens because each group member is busy completing their respective projects. The researcher also had to get around quickly to help any groups that were having difficulties. This difficulty was very difficult at the first meeting, because each group member from each group was not used to doing projects, so many questions arose. Meanwhile, at the second and third meetings, students began to get used to solving group problems on their own, and asked the researcher for help only if they felt very difficult. The learning process that takes place as described above can improve students' critical thinking skills, because students are asked to make further explanations and arrange strategies and tactics to determine actions in implementing projects and solutions to difficulties encountered.

The final process in this research is assessing the product. Products made by students are assessed through project presentations and project worksheet reports submitted by representatives of each group member. In addition to conducting assessments, the researchers also made observations that took place in each learning process at each meeting. After all groups have presented the results of their group work in front of the class, it can be determined which group has the best product and the most complete and detailed project work report, and uses reliable sources. The presentations are carried out so that students are not only active when making, but also active during presentations. At the time of presenting the results of their project work in front of the class, there were some students who were still shy to represent their groups in presenting in front of the class, so the researcher had to appoint several students to represent their groups to present projects and project reports that had been made by their groups. This is done so that all students can be involved in inter-group communication through the provision of suggestions, criticisms, and rebuttals between groups.

Based on the explanation above, it can be concluded that students' critical thinking, creative thinking, collaboration and communication skills can improve well if taught using the PjBL model compared to students taught using conventional learning. Sumarni also states that the PjBL model requires students to be more analytical and think critically by analyzing the information collected to solve problems through projects, stimulation with project assignments will motivate the emergence of student creativity individually and in groups, through experiments carried

out collaboratively can improve collaboration skills, and communication during group discussions and presentations can improve students' communication skills. Another statement that supports the statement above is the statement from Karyawati & Ashadi which concludes that students who learn to use the PjBL model have a positive influence on students' critical thinking skills, creative thinking, communication, and collaboration. Critical thinking skills, creative thinking, collaboration and communication that have been formed when making projects can be used by students in the world of work in the future because students are trained to seek information through technology, face problems, and collaborate. Redhana also wrote that the project-based learning model is one model that can be used to improve critical thinking skills, creative thinking, collaboration, and communication [25]. This is because indirectly through projects carried out by students, student activity increases because students are free to apply the knowledge and skills they have. This learning focuses more on concepts that involve students in problem solving activities.

In contrast to students who study with conventional learning, students who are taught by conventional learning do not experience the things described above because. teachers tend to explain the material using the lecture method, conduct occasional questions and answers and give assignments at home. In conventional learning, students are in a monotonous learning routine and the teacher does not provide space to create their thoughts during the learning process. Based on this explanation, it can be concluded that students who study using conventional learning do not experience learning like students who learn using the PjBL model. The next researcher calculated the correlation between critical thinking skills, creative thinking, collaboration, and communication. The correlation produced in this study is two-way, for example the correlation value of critical thinking skills to creative thinking is the same as creative thinking skills to critical thinking. Table 4.28 is a test table for the correlation between the skills tested in the study. The purpose of this test is to see the correlation between the dependent variables. The highest correlation value is the correlation between critical thinking skills - creative thinking 0.666. This value means that it has a moderate and positive level of relationship. A positive relationship shows that if critical thinking skills are high, creative thinking skills will also be higher, and vice versa. Paul and Elder wrote that the process of creating an item that involves creative thinking skills requires an assessment standard or critical thinking skills [26]. Creative thinking requires the results of critical thinking to assess and sort the results of the creative thinking process and decide what to do with the results of creativity. Critical thinking skills require the ability to think creatively to find the best solution in the project being worked on or to clearly specify the necessary steps or to generate original ideas. Birgili states that with critical thinking skills students will be able to create learning conditions that are in accordance with their standard of thinking and then students can provide new, authentic solutions to a given problem [27].

The lowest correlation in this study is the correlation between critical thinking skills – collaboration which has a correlation coefficient of 0.306 and. Although the figures shown from the results of the correlation calculations are in the low category, these results still show a good relationship between critical thinking skills and students' collaboration skills. This figure shows the level of a positive relationship, meaning that if critical thinking skills are higher, collaboration skills will also be higher, and vice versa. The results of this correlation are lowest because students are not used to dealing with problems solved in projects inside and outside the classroom. Warsono and Hariyanto also state that collaborative learning can be created by helping students to complete projects that start with investigations and end by building knowledge to complete the projects they are working on. Based on this explanation, it can be concluded that although the correlation between students' critical thinking skills and students' collaboration skills is in the low category, the two are still interrelated with one another. The researcher found when conducting research that each student interacted with one another only when they were in the madrasa environment. This is due to the long distance between one student's house and another, so students cannot help each other at all times. However, if students consistently help each other in completing their projects, then the students' critical thinking skills and collaboration skills will result in a high correlation or correlation value.

The research conducted by the researcher is different from previous studies, this is because the researcher applies this research to physics material and the instruments used to measure each separate skill between critical thinking skills, creative thinking, communication, and collaboration. Instruments of critical thinking and critical thinking researchers used test instruments in the form of descriptions, while the instruments of communication and collaboration skills of researchers used non-test instruments in the form of observation sheets.

3.2. Improving students' 4C skills taught using the PjBL model

The increase in the N-gain value of students' critical thinking skills based on Table 4.37 shows that in the experimental class (project-based learning) the N-gain increase is 75.40% (high) and in the control class (conventional learning) the N-gain increase is 53.19 % (currently). The increase in N-gain in the experimental class is higher than the increase in N-gain in the control class, this can happen because students in the experimental class are active in analyzing and looking

for problem solving (solutions) in the form of products of problems that exist in the surrounding environment. Based on the results of the data analysis described above, we can conclude that by applying the PjBL model students' critical thinking skills can be increased. This statement is in line with the results of research conducted by Sastrika, et al which states that project-based learning that involves student activity can improve students' critical thinking skills to solve problems, make decisions, research, present, and create documents [28].

This research was also conducted to measure students' creative thinking skills. Based on Table 4.38 the increase in the N-gain of students' creative thinking skills in the experimental class (PjBL model) is 90.78% (high) and the control class (conventional learning) is 46.26% (low). These results indicate that the increase in the value of N-gain in the experimental class is higher than in the control class. The increase in the N-gain of students' creative thinking skills in the experimental class was higher than in the control class because students in the experimental class were trained to think fluently by providing many ways to solve problems in everyday life presented in student project worksheets. Rauziani, et al also stated that students who are given the opportunity to develop ideas and find solutions to problems in everyday life can train students' creative thinking skills [29].

The increase in the value of N-gain which is then calculated is in collaboration and communication skills. The increase in N-gain used is the increase in N-gain at the last meeting (third meeting). The increase in the N-gain value of students' collaboration skills in the experimental class was 15.37% with the highest indicator being the indicator of managing work, which showed an N-gain of 25%. Based on the results of the N-gain calculation, it can be concluded that the collaboration ability of students in terms of managing work is the best, this is also witnessed directly by researchers, where students play an active role in managing work in project completion and evidenced by the completion of projects in accordance with the time that has been set. planned. The lowest indicator is the indicator helping the group, which is 6%. This happens because each group member has been active in completing their respective projects so that they no longer see the situation and conditions in the other groups. Meanwhile, the increase in the N-gain of collaboration skills in the control class was 3.35% with the highest and lowest indicators respectively respecting people and following agreements. Based on the description above, it can be seen that learning by applying the PjBL model can improve students' collaboration skills. A similar statement was also conveyed by Sastrika, et al in their research which states that the learning process that applies the PjBL model will provide opportunities for students to collaborate with educators so that they can improve students' collaboration skills.

The percentage of students' N-gain value in communication skills shows that the N-gain in the experimental class and control class is 80% (high category) and 56% (medium category). The percentage of N-gain in the experimental class has the highest percentage of the indicator taking information at 68% and the lowest indicator is the indicator presenting information at 42%. These results indicate that the percentage increase in N-gain in the experimental class is higher than in the control class, this is because the ongoing learning process can train students' communication skills. The ongoing learning process requires students to collect information from various media, both print media and electronic media, followed by selecting and deciding which information source to use and writing it down in the available project worksheets and presenting the results.

Meanwhile, in the control class, the highest and lowest indicators are indicators taking information 58% (medium category) and presenting information 26% (low category). This is because the learning that takes place in the classroom is only centered on the teacher so that students in the control class are not accustomed to presenting projects in front of the class. Based on the explanation above, it can be concluded that the use of the PjBL model in the learning process can improve students' communication skills. Bell in his research also states that students' communication skills can improve when students can confidently solve problems in everyday life in the form of projects [30]. The research carried out by the researcher is inseparable from several difficulties while applying the PjBL model in learning, including the researchers having difficulty in preparing the 4C instruments used in the study. The difficulties during this research did not only happen to the researcher, but also to the students. Students have difficulty using the PjBL model, especially at the beginning of the meeting because students do not understand the ongoing learning situation. So the researcher must explain the learning activities clearly so that each student can understand the learning process.

4. CONCLUSION

There are significant differences in students' critical thinking, creative thinking, collaboration, & communication (4C) skills due to the effect of applying the project based learning (PjBL) model to conventional learning and an increase in students' critical thinking skills is 75.40% (high). Improving students' creative thinking skills by 60.71% (medium). Increased student collaboration skills by 15.37% (low). The last improvement was students' communication skills, namely 57% (medium).

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