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Research-Based Learning Models in Physics for 21st Century Students

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ABSTRACT

The relevance of the Four Cs skills (critical thinking and problem solving, communication, cooperation, and creativity and invention) in the twenty-first century inspired this study. One of the efforts to achieve this goal is through the application of the Research-Based Learning (RBL) model in high school physics learning. The purpose of this study was to determine the effectiveness of the RBL model to improve students' Four Cs skills. The type of research used is R & D using the Plomp development design which is focused on the assessment phase. The data collection instrument for the four Cs skills in this study used an assessment instrument for critical thinking and problem solving, communication, collaboration, creativity, and innovation. This instrument was developed by referring to Preparing 21st Century Students for A Global Society: An Educator's Guide to the "Four Cs". Data Analysis of Student Four Cs Skills was carried out by measuring the percentage of students' achievement of Four Cs skills by comparing the frequency of skills acquired with the total number of frequencies of students' Four Cs skills. The average percentage of critical thinking and problem-solving skills reached 80, 21%, communication skills reached 82, 17%, collaboration skills reached 82, 11%, and creativity and innovation skills reached 79, 36%. The research-based learning methodology was found to be successful in increasing students' Four Cs skills during the evaluation phase.

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1. INTRODUCTION

The 21st century's rapid development necessitates the mastery of a variety of abilities, including critical thinking and problem solving, communication, cooperation, and creative and inventive thinking (NEA, 2010; P21, 2015; Bialik & Fadel, 2015). This encourages various disciplines to play an active role in developing these skills. Physics as a scientific discipline plays an important role in developing these skills (William & Beatty, 2005; Liu & Li, 2011; Sahin & Yagbasan, 2012). Given the importance of the role of the discipline of physics, it is necessary to realize effective physics learning.

Because the needs of soft skills in the twenty-first century are significantly more important than cognitive ability, physics learning should focus on building a variety of talents in pupils (Gratton, 2011; Schwab, 2016; Estuhono, 2017; Mc. Kinsey Global Institute, 2017). Physics learning design must accommodate these various skills through scientific activities such as observation, exploration, collaboration, and experimentation (Etkina et al, 2017; Wicox & Lewandowski, 2017). Observation and exploration provide space to obtain comprehensive information (Usmeldi, 2016), while collaboration and experimentation grow students skilled in collaboration and communication (Wiwin & Kustijono, 2017). Therefore, the government's active role in improving the quality of physics learning is very much needed.

According to Bentri (2017), curriculum development must be based on a study of educational theory, and practice to build a curriculum that is relevant to the demands of the times, particularly in the twenty-first century. The current government-developed curriculum is the 2013 curriculum which aims to prepare students to have skills to live as individuals and citizens who are faithful, productive, creative, innovative, and able to contribute to the life of society, nation, state, and the world. Civilization (Permendikbud Number 70 of 2013) strengthening the learning process in the 2013 curriculum is oriented to a scientific approach through scientific activities such as observing, asking, associating, experimenting, and communicating (Kusumaningrum et al, 2017; Adisendjaja et al, 2017).

According to the results of the Program of International Student Assessment (PISA) survey, Indonesian students' scientific aptitude is still among the world's bottom ten. Indonesian students' scientific ability was ranked ninth lowest with a score of 403 in 2015, second-lowest with a score of 382 in 2012, sixth-lowest with a score of 383 in 2009, and eighth lowest with a score of 393 in 2006 (OECD, 2006-2015). The percentage of correct responses on application and reasoning problems is substantially lower than in terms of cognitive ability, according to data on the average percentage of correct answers for science skills. This demonstrates that students' critical thinking, creative, and inventive thinking abilities, as well as their comprehension of physics ideas in problem-solving, are still lacking.

The Partnership for 21st Century Skills refers to 21st Century skills as Four Cs skills. Critical thinking and problem-solving skills are one's skills in giving reasons effectively, thinking systematically in making decisions, and solving problems (NEA, 2010; Trilling & Fadel, 2009). Communication skills are information sharing skills (Lippl's, 2013) by involving the ability to think, ask questions, and express ideas (Piascik, 2015). Furthermore, the Pacific Policy Research Center (2010) defines collaboration skills as a person's skills to be able to respect and work effectively with other groups. Meanwhile, creativity and innovation are skills to explore new ideas (IBSA, 2009). Although these skills are important skills in the 21st century that must be mastered by every student, the reality is not as expected.

The low mastery of Four Cs skills and students' knowledge is influenced by several factors, both in terms of students, the role of teachers, and student design. Aycan & Yumuşak (2003) in their research revealed that one of the causes of the low skills and understanding of students' concepts in physics learning is the non-experimental and theoretical treatment of physics learning materials. This raises the negative assumption of students that physics tends to be theoretical and full of mathematical formulas. Furthermore, Ahin, & Yağbasan (2012) also revealed that the active role of teachers in designing and implementing effective learning greatly influences the improvement of students' skills. Meanwhile, physics learning that has not fully integrated physics concepts in real life faced by students' causes students' creative thinking to not develop properly (Madsen et al, 2015).

The results of preliminary research conducted by Estuhono, Festiyed, & Bentri (2020) also show that physics learning that has occurred so far has not involved students fully actively in developing skills and understanding concepts in students. Learning is more likely to be dominated by theoretical concepts which lead to a negative tendency towards learning physics. In addition, physics learning also does not emphasize scientific activities by utilizing laboratories as research facilities that have the potential to make physics learning more meaningful by presenting students in the real world. Although the research findings show that physics is difficult to grasp in general, the use of an effective learning model can help students gain essential 21st-century skills (Festiyed, Djamas & Pillendia, 2018; Monica, Ricky, & Estuhono, 2021).

One of the strategic efforts in addressing the numerous challenges outlined above can be accomplished by using a learning model that incorporates the Four Cs abilities, is engaging, and meaningful, and can boost student motivation. The research-based learning model for Four Cs skills is one model that is considered effective in developing various basic skills and knowledge of 21st-century students. This is supported by the opinion (Smith & Worsfold, 2011; Sota & Peltzer, 2017) which states that learning through activities research can be used as a reform of learning physics to develop various 21st-century skills such as critical thinking and problem solving, effective communicators and team members, social responsibility, work ethic, innovative with critical judgment. The implementation of learning through research activities also encourages students to be actively involved in learning through learning by doing activities (Poonpan & Suwanmankha, 2005). In addition, the implementation of learning through research activities also provides ample space to develop critical thinking skills and encourage students' creative thinking (Elen et al, 2007; Dekker & Wolff, 2016).

The research-based learning model is principally based on constructivist, behavioristic, and cognitive learning philosophies. The main characteristics of research-based learning are learning to construct student understanding, develop prior knowledge, develop patterns of social interaction, and meaningful learning achieved through real experience (Widayati et al, 2010; Wattanatorn et al, 2014; Wannapiroon, 2014; Estuhono, Festiyed, & Bentri, 2019). The research-based learning model is also based on student-centered learning through research integration (Blackmore & Fraser, 2007; Hafiz, 2018), which can be implemented in the laboratory (Kynäslahti et al, 2006, Jyrhämä et al, 2008; Angkana & Junpeng, 2014). The main characteristics of research-based learning models facilitate the development of various 21st-century skills, knowledge and can increase students' motivation to learn physics. Based on this description, it is necessary to research the effectiveness of the Research-Based Learning (RBL) model in learning physics to improve the Four Cs skills of students in the 21st century.

2. METHODS

This type of research is development research using the development design of Plomp (2013) which has three stages, namely: 1) Preliminary Research; 2) Development or Prototyping Phase, and 3) Assessment Phase. Based on the three stages according to Plomp's (2013) development procedure, this research is focused on the assessment phase of the research-based learning model to improve Four Cs skills in high school physics learning as shown in Table 1.

Table 1. Assessment Phase

Development Stage	Research Activities	Activity Description
Assessment Phase	Summative Evaluation	Test the effectiveness of the Research-Based Learning Model to Improve Four Cs Skills in High School Physics Learning

Instruments to obtain four Cs skills data in this study using instruments skill assessment includes critical thinking and problem solving, communication, collaboration, creativity, and innovation skills. The type of data in this study is primary data, namely data taken from the results of the implementation of the Research-Based Learning Model to Improve Four Cs Skills in High School Physics Learning in the form of observations of students' four Cs skills aspects. This instrument was developed by referring to preparing 21st Century Students for A Global Society: An Educator's Guide to the "Four Cs" (NEA, 2010) and Rubrics for 21st Century Skills and Rubrics for Deep Learning Proficiencies (Catalina Foothills School District, 2015).

In the Assessment Phase, the assessment carried out was a summative evaluation, namely by conducting an effectiveness test through field trials on class XI students of SMAN 1 Koto Baru and SMAN Unggul Dharmasraya. The trial was carried out aiming to see how far the effectiveness of the model in the implementation of learning in the classroom. Data analysis of the Four Cs Skills of the Students was

carried out by measuring the percentage of the student's four Cs skill assessment using Equation (1). Observations of students' four Cs skills were analyzed using Equation (1).

$$PK = \frac{X}{Y} \times 100\% \quad (1)$$

Where PK represents the proportion of students who have mastered the four Cs, X represents the number of frequencies, and Y represents the overall number of frequencies. The classification presented in Table 2 is used to classify students' four Cs skill interpretation.

Table 2. Category of Skill Assessment Four Cs

Interval	Category	Description
75 < PK ≤ 100	V ery good	Exemplary student skills that exceed the standard
50 < PK ≤ 75	Good	Student skills have met the standards targeted at each lesson
25 < PK ≤ 50	Not good	Skills of students who have not reached the standard
0 < PK ≤ 25	Bad	Student skills are not up to the mark and need significant support

(Source: Rubrics for 21st Century Skills. (2015). Tucson, Arizona)

3. FINDINGS AND DISCUSSION

3.1. Findings

The results of the assessment of the students' Four Cs skills were obtained based on observations of these skills during the learning process and based on students' answers in the student's book. Collaboration skills are assessed when students carry out research activities in their groups, while communication skills are assessed during discussions and presentations of research results. Furthermore, critical thinking and problem-solving skills are assessed based on students' ability to analyze and interpret research data. Meanwhile, creative and innovative thinking skills are assessed based on students' ability to formulate problems and formulate hypotheses. The data obtained from the Four Cs skill assessment instrument is used to determine the achievement of these skills after students carry out learning activities. The data on the results of the student's Four Cs skill assessment can be seen briefly in Table 3.

Table 3. Results of the Four Cs Skills Assessment of Students

Meeting	Critical Thinking & Problem Solving		Communication		Collaboration		Creativity & Innovation	
	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru
1	75,23	74,83	81,87	81,36	83,33	82,57	80,07	79,82
2	80,11	79,71	83,6	81,51	82,66	82,57	75,87	74,81
3	80,09	79,9	81,45	81,32	83,68	80,63	79,29	79,5
4	82,11	81,94	83,4	82,81	82,66	81,51	81,5	81,15
Average	80,68	80,396	83,05	82,365	82,60	81,791	80,21	79,781

Based on Table 3, it is known that the average critical thinking & problem-solving aspects of students at SMAN Unggul Dharmasraya reached 80.68, and students at SMAN 1 Koto Baru reached 80.39 with the category exceeding the standard. Furthermore, on the aspect of communication skills, the average student

of SMAN Unggul Dharmasraya was 83.05, and students of SMAN 1 Koto Baru reached 82.36 with a category exceeding the standard. In the aspect of collaboration skills, the average percentage of students at SMAN Unggul Dharmasraya reached 82.60, and students at SMAN 1 Koto Baru reached 81.79 in the category exceeding the standard. Meanwhile, for creativity & innovation skills, the average number of students of SMAN Unggul Dharmasraya reached 80.21, and students of SMAN 1 Koto Baru reached 79.78, both of which also exceeded the standard.

Based on the data on the results of the Four Cs skill assessment of students after using the research-based learning model, it showed a significant improvement with the achievement criteria exceeding the standard so that it was worthy of being imitated. The interpretation of the assessment of students' Four Cs skills is carried out to determine the achievement of each of the Four Cs skills that have been mastered by students. The achievement of the Four Cs skills includes whether the student's skills are not in line with expectations and require significant support, student skills that have not reached the standard, student skills that have met the targeted standards, or exemplary student skills that exceed the standard.

The interpretation of the Four Cs skills at each meeting both at SMAN Unggul Dharmasraya and at SMAN 1 Koto Baru is explained in detail as follows:

Results of the First Meeting of the Four Cs Skills Assessment

The results of the assessment of the Four Cs skills of the first meeting students can be seen in Table 4.

Table 4. Results of the Four Cs Skills Assessment at the First Meeting

Meeting	Critical Thinking & Problem Solving		Communication		Collaboration		Creativity & Innovation	
	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru
1	75,23	74,83	81,87	81,36	83,33	82,57	80,07	79,82
Category	Exceeds Standards		Exceeds Standards		Exceeds Standards		Exceeds Standards	

Table 4 shows that the average critical thinking and problem-solving skills of SMAN Unggul Dharmasraya students are 75, 23, and 74, 83 for students of SMAN 1 Koto Baru with categories exceeding the standard. Furthermore, the average communication skills at SMAN Unggul Dharmasraya are 81, 87, and 81, 36 for students of SMA 1 Koto Baru with criteria that have exceeded the standard. As for collaboration skills, both students at SMAN Unggul Dharmasraya and students at SMAN 1 Koto Baru are above the standard criteria with an average of 83, 33, and 82, 57. Meanwhile, the average creativity and innovation skills of students at SMAN Unggul Dharmasraya have reached 80, 07, and 79, 82 students at SMAN 1 Koto Baru who have also met the criteria for exceeding the standard. The chart for assessing the four C skills of students at the first meeting both at SMAN Unggul Dharmasraya and at SMAN 1 Koto Baru can be seen in Figure 1.

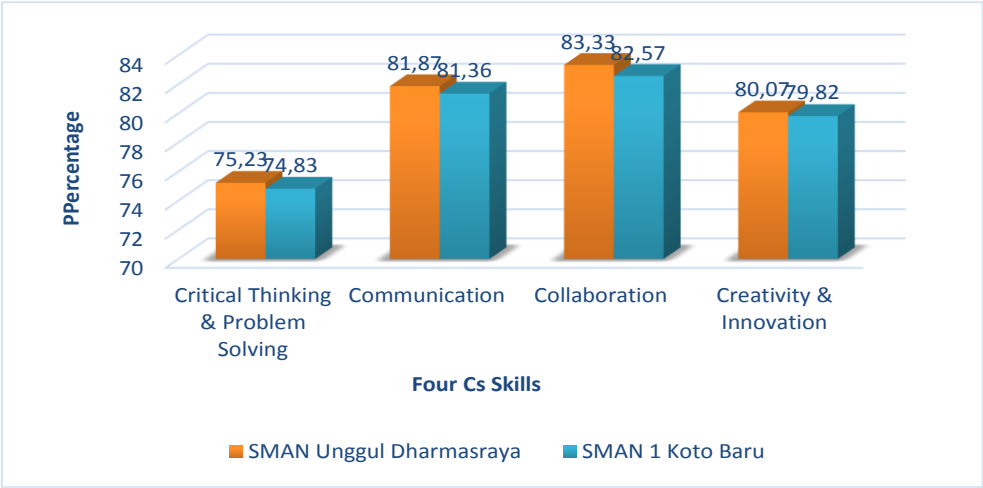

Figure 1. Assessment of Four Cs Student Skills at the First Meeting

Based on Figure 1, it can be seen that the four Cs skills in students, in general, have exceeded the standards targeted for each lesson. Four Cs skills that stand out at the first meeting are collaboration and communication skills. This is influenced by the use of research-based learning models that facilitate collaboration and the freedom to express creative ideas while respecting the opinions of others.

Results of the Second Meeting Four Cs Skills Assessment

The results of the second meeting Four Cs skills assessment of students can be summarized in Table 5.

Table 5. Results of Four CS Skills Assessment Results at the Second Meeting

Meeting	Critical Thinking & Problem Solving		Communication		Collaboration		Creativity & Innovation	
	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru
2	80,11	79,71	83,6	81,51	82,66	82,57	75,87	74,81
Category	Exceeds Standards		Exceeds Standards		Exceeds Standards		Exceeds Standards	

Table 5 shows that the average critical thinking and problem-solving skills of SMAN Unggul Dharmasraya students are 80, 11, and 79, 71 for students of SMA 1 Koto Baru with categories exceeding the standard. Furthermore, the average communication ability at SMAN Unggul Dharmasraya is 83, 6, and students at SMAN 1 Koto Baru are 81, 51 with criteria exceeding the standard. As for collaboration skills, both students at SMAN Unggul Dharmasraya and students at SMAN 1 Koto Baru are in the criteria exceeding the standard with an average of 82. 66 and 82. 57. Meanwhile, the average creativity and innovation skills of students at SMAN Unggul Dharmasraya have reached 75, 87 and students of SMAN 1 Koto Baru 74, 81 who also achieved the criteria for exceeding the standard. The chart for assessing the four C's skills of students at the second meeting both at SMAN Unggul Dharmasraya and SMAN 1 Koto Baru can be seen in Figure 2.

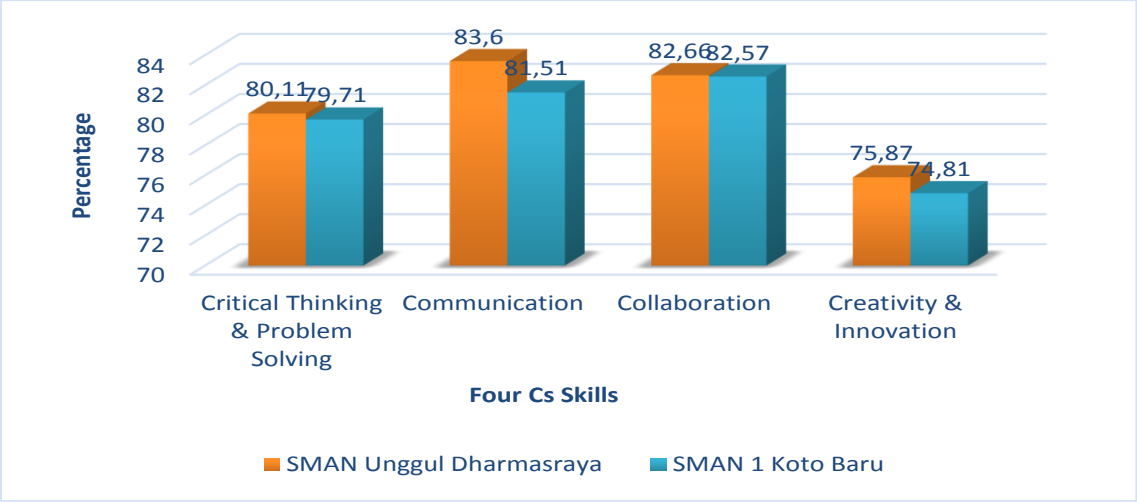

Figure 2. Graph of Student Four Cs Skills Assessment at the Second Meeting

Based on Figure 2, it can be seen that the four Cs skills in students have shown quite good development. The four C skills that were quite prominent in the second meeting were the same as the previous meeting, namely collaboration and communication skills. This shows that the research-based learning model has facilitated students in group collaboration activities and improved students' communication skills through discussion and presentation activities.

Results of the Third Meeting Four Cs Skills Assessment

The results of the fourth meeting students' Four Cs skills assessment can be summarized in Table 6.

Table 6. Results of the Four Cs Skills Assessment at the Third Meeting

Meeting	Critical Thinking & Problem Solving		Communication		Collaboration		Creativity & Innovation	
	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru
3	80,09	79,9	81,45	81,32	83,68	80,63	79,29	79,5
Category	Exceeds Standards		Exceeds Standards		Exceeds Standards		Exceeds Standards	

Table 6 shows that the average critical thinking and problem-solving abilities of students at SMAN Unggul Dharmasraya are 80, 09, and 79, 9 for students at SMAN 1 Koto Baru. Furthermore, the average communication skills at SMAN Unggul Dharmasraya are 81, 45, and 81, 32 for students of SMA 1 Koto Baru. As for collaboration skills, both students at SMAN Unggul Dharmasraya and students at SMAN 1 Koto Baru are on average 81, 32 and 83, 68 respectively. While the average creativity and innovation ability of students at SMAN Unggul Dharmasraya is 79, 29 students and at SMAN 1 Koto Baru 79, 5 students. The four Cs skills in students have reached the criteria for exceeding the standard. The chart for assessing the four C skills of students at the third meeting both at SMAN Unggul Dharmasraya and at SMAN 1 Koto Baru can be seen in Figure 3.

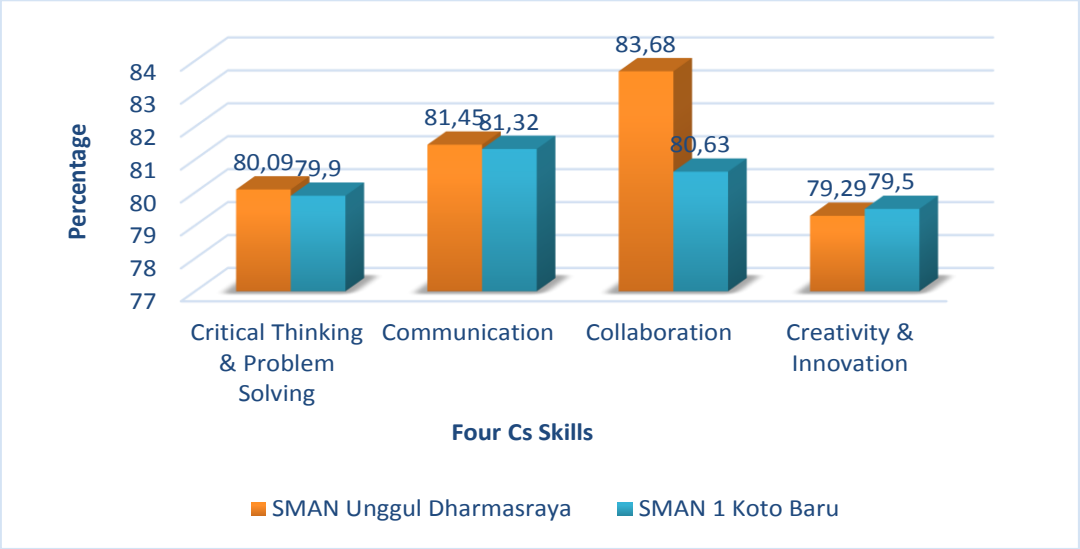

Figure 3. Graph of the Four Cs Skills Assessment at the Third Meeting

Based on Figure 3, it can be seen that the Four Cs skills at the third meeting are still dominated by collaboration and communication skills. The research-based learning model that is applied in learning activities can significantly improve students' collaboration and communication skills.

Results of the Fourth Meeting Four Cs Skills Assessment

The results of the Four Cs skills assessment of the fourth meeting students can be summarized in Table 7.

Table 7. Results of the Four Cs Skills Assessment at the Fourth Meeting

Meeting	Critical Thinking & Problem Solving		Communication		Collaboration		Creativity & Innovation	
	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru	SMAN Unggul	SMAN 1 Koto Baru
4	82,11	81,94	83,4	82,81	82, 66	81,51	81,5	81,15
Category	Exceeds Standards		Exceeds Standards		Exceeds Standards		Exceeds Standards	

Table 7 shows that the average critical thinking and problem-solving skills of SMAN Unggul Dharmasraya students are 82, 11, and students of SMA 1 Koto Baru are 81, 94. Furthermore, the average communication skills at SMAN Unggul Dharmasraya are 83, 4 and students of SMAN 1 Koto Only 82, 81. As for collaboration skills, both students at SMAN Unggul Dharmasraya and students at SMAN 1 Koto Baru have an average of 82, 66, and 81, 51 respectively. Meanwhile, the average creativity and innovation ability of students at SMAN Unggul Dharmasraya reached 81, 5, and at SMAN 1 Koto Baru 81, 15 students. The four Cs skills in students have reached the criteria for exceeding the standard. The chart for assessing the four C skills of students at the third meeting both at SMAN Unggul Dharmasraya and at SMAN 1 Koto Baru can be seen in Figure 4.

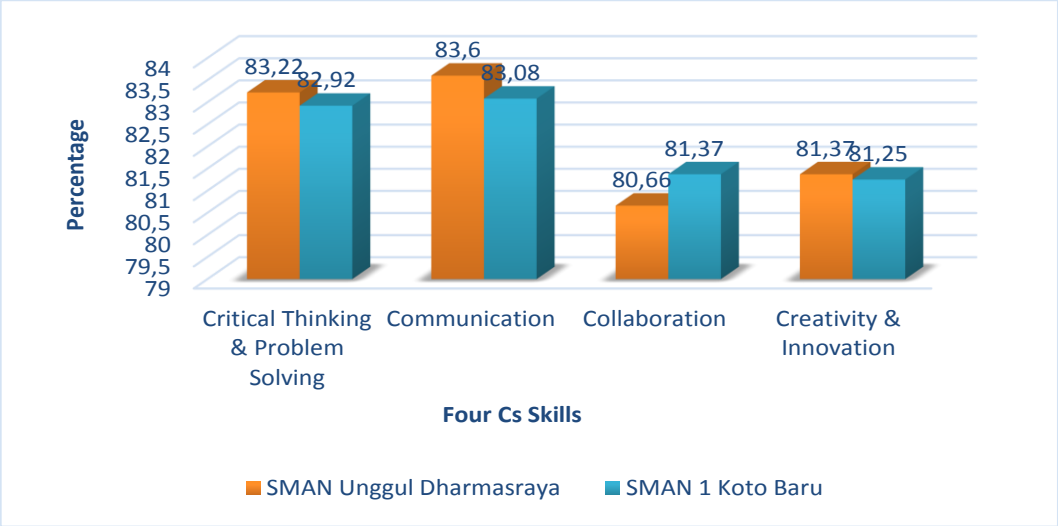

Figure 4. Graph of Student Four Cs Skills Assessment at the Fourth Meeting

Based on Figure 4, it can be seen that the four Cs skills are already in the category exceeding the standard so they should be examples for other students. However, critical thinking and problem-solving skills, as well as creativity and innovation skills, still require the teacher's role as a facilitator in improving them.

3.2. Discussion

The research-based learning model to improve the four Cs skills in physics learning was developed as a forum for developing important 21st-century skills so that one of the parameters of the model's effectiveness is the four Cs skills. The average percentage of critical thinking and problem-solving skills has reached 79.86, communication skills reached 82.70, collaboration skills reached 82.19, and creativity and innovation skills reached 79.05. The results of data analysis showed that the four Cs skills of students in the four aspects assessed showed significant achievements in the category exceeding the standard (very good).

Critical thinking and problem-solving skills help students to be open-minded, to question, not to take anything for granted, and to think and reason through problems rationally (Kompf & Bond, 2001). Facione (2011) also asserts that critical thinking and problem solving enable every student to think effectively, engage in systematic thinking, to develop skills of making judgments and rational decisions. Furthermore, Lippl (2013) explains that communication skills are skills to understand and share ideas. In line with that, Piascik (2015) adds that communication involves sharing thoughts, questions, ideas, and solutions. Research results have revealed that communication skills are very important in determining students' future success (Coulson, 2006; Muijs & Reynolds, 2011).

Eggen & Kauchak (2012) explained that collaborative work skills involve sharing social and cultural experiences among students. When applied effectively, collaboration can have a significant positive effect on every student involved in the team. The results of research conducted by Johnson & Johnson (2009) and Killen (2013) concluded that collaboration greatly contributes to increased efficiency in learning activities.

The terms creativity and innovation are often used to refer to the conscious exploitation of new ideas, or the use of new ideas, to add social or economic value (IBSA, 2009). The Partnership for 21st Century Skills (2015) reveals that creativity and innovation are requirements for personal and professional success in the current era of globalization. The importance of creativity and innovation is the foundation for the essence of one's survival. Creativity and innovation are the most important human resources because without creativity they will always be in the same pattern.

The research-based learning model positions students as active learning subjects through research activities. As active learning subjects, students will be able to explore their abilities and learning environment optimally so that learning becomes more fun and meaningful for students (Kemendikbud,

2015). Active learning directs students to play an active role in learning activities. The main characteristic of active learning is that the teacher acts more as a motivator, facilitator, mediator, and evaluator who provides a space, situation, or learning environment that makes students active in learning activities (Kemendikbud, 2015). The research-based learning model was developed as a form of meaningful learning to facilitate students in developing the four Cs skills which is one of the parameters of the effectiveness of the learning model.

The effectiveness of the next model is seen from the mastery of the aspects of students' mastery of knowledge. The results of data analysis show that the implementation of the research-based learning model in physics learning has succeeded in increasing aspects of students' knowledge as indicated by the achievement of minimum completeness criteria both individually and classically according to what has been determined for physics lessons. These results are following the opinion of Wattanatorn et al (2014) which states that the main characteristics of the research-based learning model are learning to construct student understanding, developing prior knowledge, developing patterns of social interaction, and meaningful learning achieved through real experience. The research-based learning model is also an activity of proving and conducting investigations in building knowledge, which is understood as the potential to bring students to new fields (Levy & Petrulis, 2012). In addition, Kyu & Ph (2015) stated that the research-based learning model allows students to gain learning experiences at a higher level of knowledge structure.

The implementation of the research-based learning model to improve the four Cs skills in physics learning applies collaborative learning. According to Davier et al., (2017) collaborative, research-based learning is characterized by interactions between two or more students who share ideas, experiences, and negotiate in developing students' four Cs skills. Collaborative learning will improve the four Cs skills of students. This is evident from the results of the effectiveness test that group activities and students' scientific attitudes can improve students' four Cs skills which include critical thinking skills, communication skills, cooperation, and creativity and innovation in problem-solving have exceeded the standard (very good).

4. CONCLUSION

Based on the results of data analysis that has been carried out, it can be concluded that the research-based learning model in physics learning is effective in improving the four Cs skills of 21st-century students. The development of a research-based learning model to improve the four Cs skills in high school physics learning in the 21st century provides an overview and input, especially to education providers in improving the quality of physics learning in senior high schools.

This model makes learning more interesting and meaningful because this model does not only develop aspects of knowledge, but most importantly it can develop four Cs skills and generate student learning motivation. Through this model, the teacher also plays an active role in facilitating students according to the characteristics of research learning. Through research activities by presenting the real world, making learning more meaningful for students so that the four Cs skills can be explored to the maximum. Through this model, especially the four Cs skills, students will be better than conventional learning, because in this model students are allowed to construct their understanding through research activities, collaborate with group members in problem-solving, hone communication skills effectively, and encourage creative thinking and thinking student innovation in problem-solving. This research has been attempted and carried out following scientific procedures. However, it still has limitations, namely, the trial was only carried out at one high school level considering the limited time in the study. It is hoped that for further research, the research-based learning model to improve four Cs skills in high school physics learning can be applied to all levels of high school.

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