Effectiveness Environmental Change Learning Tools Based on STEM-PjBL Towards Students' Collaboration and Communications Skills

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Article Info	Abstract
	Collaboration and communication are 21st century skills that must have everyone. Therefore, learning needs to be designed that can equip students with these skills to be able to continue to develop themselves in the 21st century. This research aims to analyze the effectiveness of environmental change learning tools based on STEM-PJBL for student collaboration and communication skills. The STEM-PjBL learning tools used include syllabus, lesson plans, teaching materials, student worksheets and evaluation tools. This research was conducted at SMA Negeri 4 Medan and SMA Negeri 16 Medan. The sample was taken using a purposive sampling method with a total sample of 126 students consisting of 4 classes. This research uses quantitative research methods with one group pretest-posttest design. Based on the results of the research showed the collaboration skills of students gained an average score of 0.817 with a very good category. Meanwhile students' communication skills gained an average score of 0.830 in the excellent category. This shows that STEM-PjBL based environmental change learning tools are effective for student collaboration and communication skills.

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INTRODUCTION

21st century skills need to be prepared for students to be able to maintain their existence. The Partnership for 21st Century Skills (2015) mentions that one of the skills that must be possessed is collaboration and communication skills. This is intended so that someone can express thoughts and ideas to solve the problems encountered effectively and efficiently, and full of responsibility.

The issue of environmental pollution has become a global issue that must be addressed immediately no exception in the city of Medan. According to U.S. Environmental Protection Agency (2017), the city of Medan is the fourth highest level of pollution in the world. This situation is caused by some Medan city residents who are less concerned about the environment. Behavior like this needs to be followed up so that problems that occur in the environment can be resolved quickly. Through effective collaboration and communication skills possessed by students, problems can be overcome with initiative without causing misunderstanding. This is what underlies the importance of collaboration and communication skills to solve environmental problems, especially in Medan city. However, learning that emphasizes aspects of student collaboration and communication in schools is still rarely done.

STEM is a learning approach by linking elements of science, technology, engineering, and mathematics in a single learning topic. The STEM approach is an alternative learning solution in the 21st century (Hernandez et al., 2014). The STEM approach creates problems-based learning in everyday life so that it can train students in applying knowledge learned in schools to phenomena that occur in the real world. According to Becker & Kyungsuk (2011), the relevance of STEM subjects in learning has a significant positive effect on student learning outcomes. Sahin (2015) states that STEM-based learning approaches can increase students' conceptual understanding, interest in STEM, research interest in higher education and develop self-confidence, skills in technology, life and career, communication and collaboration.

Project Based Learning (PjBL) is a learning model that is built based on learning activities and real assignments (projects) that pose challenges for students to solve. These activities generally reflect the type of learning and work done in students' daily lives (Goodman, 2010). Moylan (2008) said that learning by using the PjBL model is very important. This can close the gap between knowledge and the skills students have to succeed in the 21st century. Setyaningrum et al. (2015) states that learning with the PjBL model can improve learning outcomes in cognitive, affective and psychomotor.

One alternative learning that can be used to improve collaboration and communication skills is to use STEM-based learning tools that are integrated with PjBL learning models. Bicer et al. (2015) states that the instructions on the STEM-based PjBL learning model can improve student mathematics and science learning outcomes and improve student vocabulary and standards in communication. Furi et al. (2018) states that STEM integrated in the PjBL learning model shows an increase in student learning outcomes (cognitive and psychomotor aspects) and student creativity in problem solving.

In this study, the STEM approach is integrated into the environmental change learning tool which includes syllabus, lesson plans, teaching materials, student worksheets and evaluation tools. Learning by using PjBL learning syntax. The purpose of this study is to analyze the effectiveness of environmental change learning tools based on STEM-PjBL towards students' collaboration and communication skills. By using this STEM-PjBL learning tool it is expected that students' collaboration and communication skills can be improved.

METHODS

This research was conducted at SMA Negeri 4 Medan and SMA Negeri 16 Medan in class X IPA. The research sample was taken by purposive sampling technique with a total sample of 126 consisting of 4 classes of students. Research using one group pretest-posttest design according to Sugiyono (2009). Data on collaboration and communication skills are obtained by observing during learning activities in research. Learning

activities carried out during 3 meetings or 9 hours of learning by using the Project Based Learning (PjBL) learning syntax. Indicators of collaboration and communication based on the Office of the Superintendent of Public Instruction (2015). Analysis of the effectiveness of learning tools using the following formula.

$$Score = \frac{acquisition\ score}{maximum\ score}$$

Based on the values obtained, these values are grouped into several categories. The score acquisition category can be seen in Table 1.

Table 1. Criteria for the Score of Collaborative and Communication Skills

Score	Category
$0.80 \leq x < 1.00$	Very good
$0.60 \leq x < 0.80$	Good
$0.40 \leq x < 0.60$	Good enough
$0.20 \leq x < 0.40$	Not good enough
$0.00 \leq x < 0.20$	Not good

RESULTS AND DISCUSSION

The data in Table 2 below shows the results of collaboration skills using STEM-PjBL-based environmental change learning tools.

Table 2. Results of Collaboration Skills

Item Number	Indicator	Score	Category
1	Work effectively and respectfully	0.863	Very good
2	Flexibility and willingness help in discussions to achieve shared goals	0.801	Very good
3	Shared responsibilities in groups	0.787	Good
Average score		0.817	Very good

Based on the results of the assessment of collaboration skills in Table 2, the average score of collaboration skills in the highly skilled category. This result is in line with Saenab et al. (2019) and Sahin (2015) which states that learning using the PjBL model can improve students' collaborative skills. Ralph (2015) also emphasized that there is a positive relationship between STEM-based learning by using the PjBL learning model to student collaboration skills. This is evidenced by the following criteria.

1) Students are able to work together in groups effectively and respectfully with other groups. In this study, student discussions went well, no disharmony was found in the discussion although several conflicts were found such as disagreeing with the opinions of friends in one group. However, how students 'attitudes in resolving these conflicts actually enhance students' collaborative skills. This is in accordance with Lee et al. (2015) which states the conflicts found in learning activities affect the collaboration and communication skills.

2) Students are able to discuss in achieving common goals. Based on observers' observations, students have been able to listen to ideas and show discussions that allow the group to fulfill a common goal of getting good grades. This is in accordance with Fitri et al. (2018) which states that learning that exercises collaborative learning activities is related to student learning outcomes. This is because when students conduct experiments, more students work together in planning, conducting, analyzing, submitting results and evaluating with other students. This activity will help students understand concepts directly.

3) Students are responsible in groups and each individual contributes in the group. This is indicated by the progress of the project as planned, the completion of tasks on time and students get each part in doing the assignment and in doing the percentage. According to Pratiwi et al. (2018), through the activities of working together in groups with PjBL learning able to improve student collaboration skills. In addition, According to Hamidah & Palupi (2012) states that learning with the PjBL model is able to increase the attitude of student responsibility.

The data in Table 3 below shows the results of communication skills using STEM-PjBL-based environmental change learning tools.

Table 3. Results of Communication Skills

Observed aspects	Item Number	Indicator	Score	Category
Communicate clearly	1	Articulate thoughts and ideas effectively	0.819	Very good
	2	Listen effectively	0.907	Very good
	3	Use communication for various purposes	0.819	Very good
	4	Utilize a lot of media and technology. and know how to assess their effectiveness and assess their impact	0.767	Good
	5	Communicate effectively in diverse environments	0.835	Very good
Average score			0.830	Very good

Based on Table 3, the results of students' communication skills in this study indicate the highly skilled category. This result is in line with the research of Muharromah et al. (2019) which states that the PjBL learning model influences students' communication skills in the medium category. This is evidenced by the following criteria.

1) STEM-PjBL based learning shows the ability of students to articulate thoughts and ideas effectively using verbal and written communication in group work and the percentage of projects and products. Percentages are carried out smoothly and confidently. Bell (2010) states that through learning using the PjBL model, students are able to master new technological skills and be able to develop them and be able to become skilled communicators and problem solvers. However, some students were found to lack confidence in conveying ideas. This is because students are less able to master the material so they lack confidence when delivering their ideas. Therefore, communication skills still need to be trained to students by using STEM-PjBL based learning tools so that maximum results are obtained.

2) Students listen effectively to decipher meanings, including knowledge, values, attitudes and intentions. In this study students listened very well to the explanation of the teacher or other students, so students understood the intended message. This is demonstrated by the implementation of the investigation process and the project to make products to address the problem of environmental change very well in accordance with instructions.

3) Students use communication for various purposes. This is indicated by students being able to provide information, instruct, motivate, and persuade both in their groups and in larger groups. In this study students are trained to be able to communicate skillfully both in small groups and in percentages of classes so that students are trained to communicate effectively.

4) Students utilize a lot of media and technology, and know how to assess their effectiveness and assess their impact. However, there are still some students who have not used the media in learning activities. This is evidenced by the unavailability of learning resources owned by students. Students only utilize learning resources that have been provided in this case teaching materials and textbooks. Students feel the teaching materials that have been available are sufficient to use.

5) Students communicate effectively in diverse environments. In this study students have been able to submit opinions or ideas, ask questions, and instruct clearly, in the form of giving direction, instructions and instructions with the group or other groups using verbal and nonverbal communication. This is in accordance with Bicer et al. (2015) which states that instruction obtained at PjBL with the STEM approach can improve student learning outcomes and be able to improve students' vocabulary and standards in communication.

According to Paruntu et al. (2018) students' communication skills can be influenced by the PjBL learning model. This is due to the learning tools compiled by researchers with the PjBL learning approach by integrating STEM aspects, training students to be able to develop

communication skills including project discussion activities, project implementation, and the percentage of project outcomes that require students to be able to appear to explore their communication abilities. Utami (2016) states that there is a relationship between students' communication skills and learning outcomes. Therefore, students' communication skills will be better if they continue to be developed in STEM-PjBL based learning activities to maximize other learning outcomes for students. According to Umar (2012), good communication skills will make students tend to adapt more easily to whoever the student is, both in a community and in the community, which will eventually become a successful person in his life.

CONCLUSION

Based on the results of the study, it can be concluded that STEM-PJBL-based learning environment change is effective towards student collaboration and communication skills. This is evidenced by the average score of the acquisition of collaboration and communication skills in the very good category.

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