



THE SCIENCE LEARNING MATERIAL USING PjBL MODEL INTEGRATED WITH SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) APPROACHES TO ENHANCE STUDENTS' COMMUNICATION SKILLS

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Received: February 03, 2020

Accepted: March 09, 2020

Online Published: April 30, 2020

DOI : 10.20961/jkpk.v5i1.39665

ABSTRACT

This study aims to develop a science learning material using PjBL model integrated STEM approaches to enhance students' communication skills. The method used is the 4D Research and Development (R&D) model and an experimental method for testing the effectiveness of the device. The study population was all VII class in one of the junior high schools in the South Tangerang region with samples taken using a random sampling technique of 76 people. The instrument used was a device feasibility test sheet and an observation skill communication sheet. The data obtained were then analyzed quantitatively and qualitatively. The results showed the components of the learning device in the form of syllabus, lesson plans, teaching materials and student worksheets, were very feasible to use with an average of 3.62. In addition, each item validity assessment instrument is also declared valid for use. The observed communication skills also increased from 1.59 to 3.15 with a gain value of 0.64 (medium category) for the experimental class. Meanwhile, the gain value for the control class is 0.005 (very low category). The difference in the gain value indicates that the learning device is effective in improving students' communication skills.

Keywords: learning materials, PjBL models, STEM approaches, communication skills

INTRODUCTION

Competition in the era of globalization requires competent human resources to survive. Competent human resources, in this case, are not only seen from hard skills but also must be accompanied by excellent soft skills. Graduate users, in this era, see soft

skills as the ability they most need from job seekers. The ratio of soft skills and hard skills needs of graduates in the world of work, according to NACE (National Association of Colleges and Employers), is 82% for soft skills and 18% for hard skills [1]. It proves that graduate users prioritize graduates who have better soft skills.

One of the most important soft skills is communication skills. It is because the current graduate users need job seekers or HR who can communicate effectively [2]. Besides several research results also place communication skills as the first order of soft skills that are highly needed by the business world/industry with the highest frequency of needs sought by graduate users [3,4,5].

Unlike the case with needs, the reality happening in the world of education today is just the opposite. At present, the educational model in both primary and tertiary education is 90% focused only on technical skills (hard skills), and only 10% is focused on developing soft skills [6]. It, then, gets the government's attention more seriously. The government, in this case, emphasizes the development of soft skills by forming the 2013 curriculum.

The 2013 curriculum requires three primary learning outcomes, one of which is a skill. Communication skills are soft skills that are included in the types of abstract skills, demands from the 2013 curriculum. These skills are also essential in the 21st century, along with other skills of thinking and learning [7], [8]. Communication skills in learning science can be improved by applying appropriate planning, implementation, and assessment of results. Those three things can be specifically contained in the science learning administration that is adapted to the learning model in the 2013 curriculum. One such model is the Project-Based Learning model (PjBL) [7,9]. This model was chosen because it can provide opportunities for students to construct their knowledge based on the

assigned project. Also, each step in the PjBL model can provide opportunities for students to develop their communication skills [7]. These two things become the basis for using the PjBL model in this study.

The PjBL is also "an approach to instruction through a project" [10]. One suitable approach is the Science, Technology, Engineering, and Mathematics (STEM) approach. The PjBL model, which is integrated with the STEM approach, is assumed to be able to improve communication skills [7,9]. It is because the syntax of the model requires good communication among students. The syntax is expected to practice and improve communication skills possessed by students.

The STEM is used to emphasize an understanding of the integrated disciplines of Science, Technology, Engineering, and Mathematics as well as their importance in the long-term academic success of children, economic well-being [11], and community development [12]. STEM education is promoted in many countries to prepare their citizen to comprehend STEM and have multidimensional abilities use in modern life [13]. STEM education has been recognized in the U.S. as an essential educational reform and described as an instructional approach to prepare children for the century's global economy [14]. STEM education is now being implemented by several countries and becomes one of the primary trends in global education. In Taiwan, the learning curricula began to be integrated with the STEM curriculum and made students the focus of learning activities [15].

One of the materials in junior high school science learning is material about the classification of materials and their changes. This material is deemed necessary to get more attention because, in the absorption capacity of the national exam, this material is still below 55%. Indicators of separation of mixtures, changes in physics/chemistry, solutions of acids, bases, or salts that are part of the material classification subject matter and its changes, have national absorption capacity below 55%, namely 40.54%, 32.75%, and 33.77%.

Unlike the case with some of these studies, in this case, there has been no research specifically developing science learning administration employed PjBL model integrated with STEM in improving students' communication skills and understanding of concepts, in the junior high school, South Tangerang area, on material classification subject matter and its changes.

METHODS

The method employed in this study was a research and development method, with the 4D model (Define, Design, Development, and Disseminate) [16]. However, specifically, this research only carried out three stages without undertaking the *disseminate* stage. In addition to these methods, this study also used an experimental method to test the effectiveness of learning administration that had been developed. The population of this research was the whole VII grade in one of the junior high schools in the South Tangerang area. The study sample was 76 people divided into 38 people each in the experimental and control classes. The data collection instrument was

in the form of a feasibility test sheet of learning administration and a communication skills observation sheet.

The validity test of the learning administration was carried out by ten validators, consisting of experts in the fields of natural science learning, teaching materials, learning administration, assessment instruments, and educational practitioners. Data on students' communication skills were obtained from observations made by two observers in each class to minimize the subjectivity of researchers. The collected data were then analyzed quantitatively and described descriptively. The improvement of communication skills, in this case, was analyzed by looking at the Gain value of communication skills before and after using the development result of learning administration. The learning administration was effective if the Gain value was at least in the moderate/sufficient category.

RESULTS AND DISCUSSION

The results of the development of the learning administration in this study were divided into three main parts, namely the characteristics of the learning administration, the feasibility, and the effectiveness of the learning administration being developed. Development tools generally had characteristics that are in line with the learning steps of the PjBL model integrated into the STEM approach. The learning administration developed had student-centered learning characteristics. It was done so that students could build their knowledge independently.

Table 1. The learning steps of the PjBL model integrated the STEM approach

Learning Steps	Activities
<i>Reflection</i>	Giving essential questions for students
<i>Research</i>	Exploring to find solutions
<i>Discovery</i>	Solution discovery and project design
<i>Application</i>	Making products according to product design and testing
<i>Communication</i>	Communicating products that have been tested

The whole learning steps, in this case, were contained in every component from the syllabus to the developed Student Worksheet (LKPD). The learning steps of the PjBL model integrated the STEM approach are presented in Table 1. In general, the learning administration developed included learning that centered on students (student-centered). Student-centered can support learning objectives to be achieved with an appropriate learning model [17]. It can be done because, basically, the PjBL model allows students to construct their knowledge. This statement is in line with the results of the study, which stated that the PjBL made students able to conduct investigations independently and fostered collaboration skills [18]. These two things, in general, can make students develop other abstract skills, including communication skills.

In addition to the PjBL learning model integrated STEM approach, the aspects of the STEM approach itself were loaded more clearly in each component of the learning administration. It was done to give an idea to teachers and students about STEM aspects that must be empowered in each indicator of the subject matter. There were four aspects of STEM, all of which were part of the developed learning administration, namely science, technology, engineering, and mathematics. The

STEM aspects in each part of the device are expected to be able to develop the skills that are the objectives in the 2013 curriculum. It supports the opinion that the STEM approach in learning science must be focused on solving problems in daily life, or even in professional life [19]. It clearly illustrates that learning science using the STEM approach is expected to be able to solve problems in learning in the classroom or wider scope. Solving these problems can certainly be helped by emphasizing aspects of the STEM itself [20]. Therefore, each component in this learning administration was characterized by the STEM aspects contained therein. More clearly, the results of the development of the learning administration and the STEM aspects contained can be seen in Figure 1 and Figure 2.

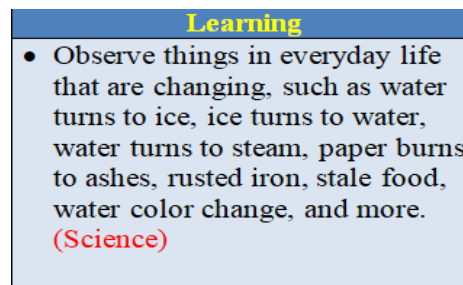


Figure 1. STEM components in the product development (Syllabus)


Activity	STEM Component
Introduction (15 min)	
Pray before starting the lesson	
The class monitor reports students who did not attend and their reasons	
Divide groups heterogeneously	
Teacher gives Student Worksheet to each group	
Describe the ill define problem based on the image provided	
	Science

Figure 2. STEM components in the product of development (lesson plan)

Table 2. Recapitulation of the results of the feasibility test component of the learning administration

Aspect	Learning Validator	Material Validator	Media Validator	Assessment Validator	Education Practitioners	Average	Category
Syllabus	3.80	3.78	3.86	3.44	3.97	3.77	Very decent
Lesson plan	3.54	3.6	3.89	3.18	3.84	3.61	Very decent
Teaching Material Student	3.43	3.47	3.84	3.04	3.86	3.52	Very decent
Worksheet (LKPD)	3.50	3.40	3.91	3.27	4	3.61	Very decent
Average Value of Learning Administration						3.62	Very decent

The learning administration developed was also tested for feasibility before used. This feasibility test was carried out using a feasibility test instrument that contained statements related to each component of the learning administration. The feasibility test results can be seen more clearly in [Table 2](#).

[Table 2](#) illustrates that each component of the learning administration from the syllabus to the student worksheets was very feasible to use. Overall, the average value of each component of the learning administration was 3.62, with a very decent category. It shows that the learning administration developed was suitable for use. However, some things needed to be improved based on the suggestions from the validator. One way was to write down and explain each step of learning and the final demands of learning on students. It was conducted so that students were not confused when learning was done [\[21\]](#).

Different from the other four components, the assessment instrument, in this study, was validated using the Aikens' V formula. The validation results showed that the average value of V for each item of assessment instrument validation was 0.87. This value was higher than the p-value at the significance level of 0.05 or 5%, with a total of 10 raters. It indicated that each validation

item for the assessment instrument was valid. It means that the assessment instruments, especially for communication skills, already had clear usage instructions, in accordance with Competencies and Basic competencies, and had clear results scoring guidelines as well. Based on the results of the feasibility test that has been described, it can be seen that each component of the device was feasible and valid to be used.

Table 3. Observation Results of Communication Skills

Class	Pre-test	Post-test	N-Gain	Category
Experiment	1.59	3.15	0.64	Moderate
Control	1.62	1.64	0.005	Low

After the feasibility test was carried out, the learning administration of the development results was then tested for effectiveness. This effectiveness test was done by applying the learning administration in the classroom. The results of testing the effectiveness of learning administration in improving communication skills can be seen in [Table 3](#).

[Table 3](#) reveals that the communication skills of students had increased after the implementation of the science learning administration of the PjBL model integrated the STEM approach. It can be seen from the

Gain value in the experimental class, which was included in the moderate category. As explained earlier, this value indicated that the learning administration was effective and enhanced students' communication skills. This fact could also be seen from the average data in the control class that had not significantly increased with a very low Gain value. The control class, in this case, was a class without the application of learning administration that had been developed.

Table 4. Observed Communication Skills Indicators

No	Communication Skills Indicator
1	Asking question
2	Group Interaction
3	Express Thought/Ideas
4	Answer the question
5	Use of Language
6	Communication with the Audience
7	Systematic Presentation
8	Presenting Data
9	Discussing Observation Results
10	Make a Conclusion
11	Give advice
12	Using Indonesian Spelling (EBI) in Writing

There were several communication skills observed in this study. These skills can be seen in Table 4. Each indicator of observation of communication skills in Table 4 had improved after using the learning administration of the development results. This increase could be caused by several things, one of which was a supportive learning model. It is in line with the opinion, which stated that a learning model must be able to support students to be more comfortable to submit, answer, and express thoughts or ideas [21].

The increase in communication skills that occurred indicates that the PjBL model integrated the STEM approach provided

opportunities for students to be more comfortable in submitting, answering, and presenting ideas that are one part of communication skills. The learning administration of the PjBL model integrated the STEM approach to support the improvement of communication skills. It is in line with several research results, which revealed that learning models, such as Cooperative learning models, Inquiry, Project-Based Learning (PjBL), and Problem Based Learning (PBL), could improve students' communication skills [7], [22].

A comfortable learning atmosphere, in this case, was one of the things that must be appeared by the models, methods, and approaches used to improve communication skills. Comfortable circumstances in conveying observations, discussion results, and other things that need to be presented can be realized by communicating effectively. Five things need to be considered, namely respect, empathy, audible, clarity, and humble [22]. *Respect*, in this case, is done by giving awards to each of what is conveyed by students. Besides, criticism must also be made with respect. It means that every student has self-esteem and pride that must still be considered in every award and criticism given [22].

Respect, in this case, must not only be instilled by the teacher but must be accustomed to being done among students. With respect, students will easily be able to express thoughts and ideas and present them without having to feel afraid of being wrong. The second thing is to empathize with students. *Empathy*, in this case, relates to the teacher's understanding of the state, behavior, and desires of students. By giving empathy to students, learning messages delivered will be

easy to receive. The next one is *audible* or listened to and understood well. The meaning of this *audible* is that the message delivered can be easily received by students.

The fourth thing that needs to be done is *clarity*, which means openness. *The clarity* in learning will lead to the confidence of students to the teacher or fellow students. The last thing to note is that *humble* is a situation where someone respects others, wants to listen, accepts criticism, is not arrogant, and does not look down on others. These five things are essential and need to be applied in every learning process that is carried out [23].

The five things that become the conditions for effective communication, in this case, had generally been carried out in the application of the science learning administration of the PjBL model integrated the STEM approach. It agrees with the results of the effectiveness of the learning administration that showed the results of improved communication skills.

CONCLUSION

The learning administration developed had the characteristic of emphasizing every aspect of STEM in each of its components and was already suitable for use, with a mean value of 3.62. The learning administration developed was also effective in improving students' communication skills with a Gain value of 0.64, which included in the moderate category.

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