IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388,p-ISSN: 2320–737X Volume 7, Issue 3 Ver. II (May. - June. 2017), PP 21-26
www.iosrjournals.org

Fostering Students' Scientific Communication through PjBL-based Communication Activities

Wirawan Fadly[1], Wasis[2]
[1](Department of Natural Science Education, State Islamic Institute of Ponorogo, Indonesia)
[2](Department of Physics Education, State University of Surabaya, Indonesia)

Abstract: *The purpose of this research was to determine the effectiveness of project-based learning (PjBL) designed using communication activities which is abbreviated as a Production model to foster scientific communication skills. The method of this research was experiment with static-group pretest-posttest design. The sample was chosen by purposive sampling in the pilot stage and stratified proportionate random on the implementation. Data were collected by using questionnaires, observations, and tests that were then analyzed based on data characteristics. The analysis used is descriptive qualitative, quantitative descriptive using N-Gain, and inferential statistic using mean comparison test. The result of the research shows that Production learning model can foster scientific communication skill which includes reading ability, writing, representation, presentation and observation significantly.*

Keywords - *Production learning model, scientific communication skill.*

I. Introduction

One of the problems facing education is the weakness of the learning process. In the learning process, learners are less encouraged to develop communication skills. The process of learning in the classroom is directed to the ability to memorize the discussion, the brain is forced to remember and hoard information without being given space to transfer that information to the public. Social interaction with society must be preceded by contact and communication.

Communication is one of the main components in supporting 21st century learning [1]. Teaching communication also serves as one of the skills of the *production* learning model, which is to support the curriculum because it can develop the potential of learners to be able to think reflectively for solving social problems in the community. Communication is also an important part of physics learning. The high school curriculum [2] [3] core physics competencies include being able to plan experiments, conduct experiments according to scientific rules, and communicate scientific knowledge/experimental results. Skills to be able to communicate scientific knowledge/experimental results are also referred to as scientific communication skills [4].

From the results of preliminary research conducted on one of senior high school in Bojonegoro city, found that students' communication skills are still not in accordance with expectations [5]. Ability to communicate effectively on learning Physics at school in the middle level with the average value of school 66. Distribution of value acquisition as much as 10% obtained A (Very Good), 50% obtained B (Good), 40% obtained C (Enough) and no Students who earned D (Less) and E (Very Less). When viewed from the aspect, encoding is an aspect that needs to be addressed in developing effective communication skills. Findings on scientific communication skills indicate that students' scientific communication skills are low in grade with the average value of school 62. Distribution of the acquisition value of 35% obtains B, 45% obtains C, 20% obtains D, and no students get A, nor E. When viewed in each of its aspects, the lowest score on the ability of scientific reading is in the aspects of understanding the vocabulary of Physics, scientific writing on aspects of insight, presentation of information on the aspects of delivery, representation of knowledge almost on all aspects, and scientific observation on the questioning aspect.

Based on the results of the preliminary research, it is known that physics learning that has been so far has not been able to facilitate students to have the ability to communicate the science to the community, so it takes an alternative solution in the form of learning model that emphasized on project-based learning that can improve students' communication skills. The learning model that can be used as an alternative solution is a *production* learning model.

The *production* model is a project-based learning model designed with attention to the elements of science and communication skills. This element of science is based on the classification developed by Popper [6] which states that in teaching science it is necessary to consider the main elements that include cognitive structures, cognitions, processes and conceptual structures and supporting elements that Vygotsky [7] refers to social interaction. While communication skills serve as a basis for teach students to be able to reflective thinking and able to communicate the results of his work to the community. *Production* model consists of six phases that include: 1) the essential problem, 2) recitation, 3) investigation, 4) designing a project plan, 5) discussion, 6) reflection, and 7) project fair. Through *production* learning model students will be facilitated to interact socially so that indirectly can realize the transfer of knowledge, as well as provide space for students to be creative. Therefore, research will be implemented of *production* physics learning model to foster scientific communication skills.

II. Research Methods

The method used was experimental design with static-group pretest-posttest [8]. The research location used is in state senior high school at Bojonegoro. In trials carried out in class X-PMS 2, and the implementation in class X-PMS 3 and X-PMS 4. The research sample was selected by purposive sampling in the pilot phase and stratified proportionate random on implementation. Data were collected by using questionnaires, observations, and tests that were then analyzed based on data characteristics. The analysis used is descriptive qualitative, quantitative descriptive through N-Gain, and inferential statistics using t-test.

III. Results And Discussion

Production learning model is the development of project-based learning developed by Fadly [9]. *Production* learning model consists of seven phase which include: 1) essential problem, 2) recitation, 3) investigation, 4) designing plan project, 5) discussion, 6) reflection, and 7) project fair. At the essential phase the learning problem begins with presenting the essential problem that is showed by the various phenomena of physics in accordance with the reality of everyday life. Presentation of the essential problem is an attempt to bring up the initial conception of students. Problems can challenge students to think [10]. This initial conception can be established by asking students to write down what students already know on the topic or by answering some questions the teacher has given. Activities at this phase more emphasis on science communication skills that is in observing the phenomenon. The purpose of this phase is to focus students' attention by relating the topic studied to the phenomenon around the student.

The recitation phase, at the time of the verbal exchanges took the form of questions and answers of teachers and students in understanding the information. At this phase the teacher communicates by asking a series of questions in the form of discrepancies to the students. By doing recitation, students have the opportunity to compare with the work of others, can learn and deepen the results of other people's description, so that will expand the knowledge and experience of students [11].

The investigation phase, the learning activity gives students the opportunity to conduct investigations freely. Students are invited to conduct an investigation through the activities of communication that is seeking information or reading references relevant to the topic of conversation. This activity can give students physical experience and social interaction. This experience encourages cognitive conflict, and causes students to ask questions about certain concepts that are inconsistent with the original conception. With this cognitive conflict students will be able to discover new knowledge. Investigation through detailed observation and systematically assess the possibility of students to develop understanding through various learning activities and correct results according to the development of students through [7].

In the designing plan project phase, the teacher still involves the students in the process, where the student is asked to design the project plan based on the new knowledge that has been obtained in the previous phase. Planning is done collaboratively between teachers and students. In planning activities, students are directed at activities to be able to perform activities of scientific writing through the identification and manufacture of work procedures. After the planning is done, then carried out the implementation of project activities. In carrying out the project, students must apply their knowledge to identify questions through research, investigation procedures, product design, results of data collection and analysis and make conclusions [12]. From the implementation of this activity students are expected to create a work or find solutions to solve a problem.

In the discussion phase, the activity of the teacher and the students or students and other students interact and share ideas and opinions. The purpose of this phase is to form a learning community and understanding of scientific determination. Students find it easier to understand and understand difficult concepts if they discuss each other's problems [13]. This is supported by the opinion that open discussion with students asks each other and answers questions better than predominant activities to develop arguments among students [14]. Discussion activities and critiques of other groups can assist the group in negotiating valid conclusion criteria, increasing understanding of social construction from scientific knowledge, and creating community of learners because students not only build knowledge but also work together to create a learning environment. From some of these opinions indicate that the discussions that occur emphasize the social interaction in which teachers facilitate students to do the activities of communicating science, namely presentation and representation of project results to other students.

At the reflection phase, teachers and students reflect on the project activities they have undertaken. This reflection activity aims to evaluate, know the feelings and experiences of students during the completion of the project. Reflective thinking can help students acquire skills and productive thinking processes [15]. This reflection activity aims to analyze and evaluate the project activities and to know the students' feelings and experiences during project completion. Reflection can form a mental process that enables students to stimulate critical thinking in testing the information obtained, asking questions about the truth and summarizing based on the ideas generated [16]. Teachers and students can do reflection activities by using discussions to improve performance during the learning process, so that through reflection is expected to find a new finding to answer the problem.

Project fair phase of learning is done by exhibiting the results of science projects to the public. Exhibits of science project results are activities in which learners present, and address research questions, methodologies, and findings from their science projects. At this phase is actually almost the same as the phase discussion, but has differences in terms of audience and way of presentation. The audiences faced are the general public having different characteristics and knowledge. This causes students to be able to communicate effectively in accordance with the knowledge of the community. Students are also required to be flexible in conveying their knowledge. Presentation in exhibition of science project can be done through various media such as posters and pictures that represent the result of the project. The role of teachers at this phase is to guide and provide a good model of how to communicate. The exhibition of this science project will provide an opportunity for students to practice investigating and can serve to motivate students' interest in science, develop skills and beliefs for problem solving and improve critical thinking and learning ability [12].

Results of the assessment science of communication skills by applying the model developed through the trial testing and the implementation. The trials conducted on 20 students, it aims to know practicallity of the *production* models in terms of improvement of communication skills of students before and after, and also it can be known the characteristics of learning have been undertaken.

The data processes show that the overall increase in the value of the scientific communication skills to the average N-Gain increase in 0,45, with details of 17 of the 20 students rose to the medium level, and the remaining three students increased by a low level and there is no increased into high level. This indicates that the application of the model *production* can improve students' scientific communication skills at a medium level.

Based on the research results can be seen that the score of communication skills before obtained an average score of 53 and after learning by applying the model of *production* increase in the average score 74 with an increase (gain) of (0,45) or at the medium level. The results of data processing of the scientific communication skills are classified into each indicator. The results were as follows:

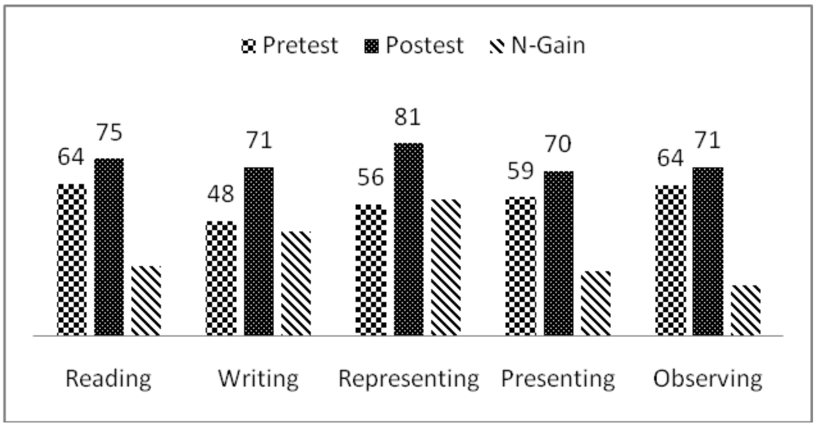

Fig 1. Data processing scientific communication skills are classified into each indicator

Based on Fig 1 shows that the indicators of scientific communication skills consist of reading, writing, representing, presenting and observing. In the aspect of reading average value before and after the application of each *production* models are 48 levels and 75 levels, it can be said that an increase of a maximum of 56%. Increasing N-Gain of scientific communication skills on aspect this reading 0,52, which means that it can improve the reading skills at the level of medium level. This shows that the *production* learning model can improve the ability to read and as a conceptual tool to help students analyze, interpret, and communicate on scientific ideas.

In the aspect of writing, the average value before and after the implementation of each model of *production* is 48 and 74, so it can be said that an increase of 54%. The increasing of N-Gain of scientific communication skills on aspects of writing is 0,5 which means that it can help to improve the ability to write a scientific level students of medium level. By having the ability to write a scientific, it can be said that the students can describe and discuss a problem and pour it in a systematic and structured result.

In the aspects representation, the average value before and after the application of each model of *production* is enough, 58 and 80. So it can be said that an increase 36%. The increasing of N-Gain scientific communication aspect of this representation at 0,51, which means that it can help improve the level of knowledge representation to medium level. Thus it can be said that *production* models capable to facilitating the students to understand the abstract scientific concepts change into concrete forms.

At the presentation aspects the average value before and after the application of each model of *production* is enough, 57 and 66. This suggests that an increase in the lowest 17%. The increasing of N-Gain scientific communication skills presentation aspects of science at a low level that is equal to 0,22. This shows that the model of *production* is not maximized in helping students to improve the ability to deliver and explain the ideas. Therefore, in next the testing phase the *production* models need to be strengthened on the syntax of discussion and project fair.

In the aspect of powers of observation, the average value before and after the application of each model of *production* is enough, and 57 and 73. This suggests that an increase of 29%. The increasing of N-Gain of scientific communication aspect of observation at 0,38, which means that it can help improve the ability to observe the level of medium.

The scientific communication skill not only analyzed, but also analyzed by statistical test. However, before doing statistical tests first done normality and homogeneity test questions in order to determine the analytical techniques used, whether parametric or non-parametric. The results of the normality of the test students' scientific communication skills pretest is displayed in the sig Kolmogorov Smirnof column of 0059. This shows that on the test pretest obtain Asymp.Sig value greater than $\alpha \pm$ (0,05), from the result of normality test can be argued that the data distribution is normal. The results of the normality test posttest scientific communication skills of the students shown in column sig Kolmogorov Smirnof at 0,200. This shows that on the test posttest gain Asymp.Sig value greater than $\alpha \pm$ (0,05). Normality test results can be said that data distribution scores after learning also normally distributed. It can be concluded that the available data are normally distributed. Thus, the fulfillment of these assumptions, so the type of testing that is used to test the hypothesis in this study using parametric statistical tests or rather can be done by t-test.

The hypothesis testing results before and after the implementation project-based learning model shows that there is a significant increase between the skills of scientific communication students before and after the learning activities. Generally, in this trial showed that by applying the model of *production* can improve the students ability to communicate science, so that, that students become more motivated to learn, the classroom atmosphere becomes more interactive, emphasizing social interaction between students, the transfer of knowledge as well as providing space for students to be more creative.

The next testing phase is implementation. This is done in order to know the effectiveness of the learning model in improving scientific communication skills. This implementation is done on two classes that have the same characteristics, but the learning model used for teching and learning prosses is different. Obtaining an average score of preliminary tests, final test and N-Gain the experimental class and control class can be seen in Table 1 below:

Table 1. An average score of preliminary tests, final test and n-gain the experimental class and control class

Scientific communication Indicators	Class Experiments			Control Class			N-Gain
	Pre-test	Post-test	N-Gain	Pre-test	Post-test	N-Gain	
Reading	72	82	38	68	72	13	29,1
Writing	39	68	47	63	72	24	30,3
Representing	52	72	41	72	74	7	37,1
Presenting	60	77	42	67	70	8	36,5
Observing	64	70	18	65	70	16	2,20
Average	**57**	**74**	**39**	**67**	**72**	**14**	**28,6**

Table 1 indicates that the average score of students' preliminary test of the experimental class is 57, while the average score of preliminary tests on the control class is 67. The results of the mean difference test (t-test) at the beginning of test scores shows the value t count amounted to 0,055, and t-tables at the level of 0,05 at 2,04 with a P 0,956. From these results it can be concluded that in general the initial ability of students in the second grade before the learning process does not differ significantly.

Furthermore, based on the average score of the final test of both, it is known that the average score of the final test of the experimental class is 74, while the acquisition of the average score of the final test is 72. This shows that, in general, there is an increasing skills of scientific communication. The test results mean difference (t-test) at the end of test scores shows the value t count amounted to 4,25 and t table at the 0,05 confidence level of 2,04. From these results it can be concluded that the ability of the students after a learning process on both classes differ significantly. Improving in the average score of N-Gain percentage is the experimental class by 39% and 14% of control class. The average N-Gain both classes included in the medium and low level. The percentage of N-Gain the experimental class is higher than the control class.

After was analyzed on data distribution normality of preliminary tests, the final test, and as well as N-Gain of both classes done. The analysis showed that the value of $\chi 2$ is smaller than $\chi 2$ tables = 7,81 at α = 0,05. It can be concluded that the preliminary test, the final test, and N-Gain of both the experimental class and control class is normally distributing. In addition to normality test, homogeneity test data is also performed preliminary tests, the final test, and N-Gain both classes. Results of homogeneity test score data on the preliminary tests, the final test, and N-Gain of experimental class and control class is smaller than F_{table} = 1,69 at the level of α = 0,05. It can be concluded that the second variance is homogeneous class.

Furthermore, the N-Gain test done to determine the different significance in the level of the improvement of capabilities of both classes. This test can be done because the data were normally distributed. The results of t-test showed that t_{count} by 4,41 and t table at the level of 0,05 at 2,04 with P at 0,00011. Based on these results, it can be concluded that there is a significant difference between the increase in the ability of the experimental and the control class, where the students' ability experimental class is higher than the control class.

Not only analyze N-Gain and statistics on the students score, but also analyze the average achievement scores of preliminary tests, the final test, and N-Gain on every aspect of the skills on the experimental and control class. This is done to look precisely on its aspects in order to know the weaknesses and strengths. The comparison of the value of its aspects is as follows:

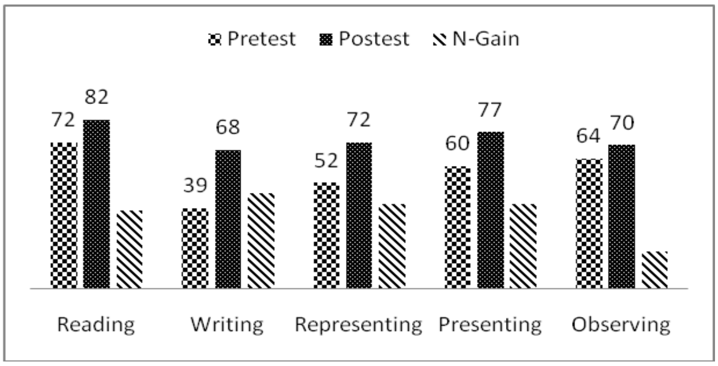

Fig 2. The score of scientific communication in experimental class

Based on Fig 2, it is known that the highest improvement of the experimental class skills is the ability to write, and then followed by the skills of reading, representation and presentation. Aspects of observations obtained the lowst improvement. Based on this it is necessary to emphasis on syntax investigate of the *production* models.

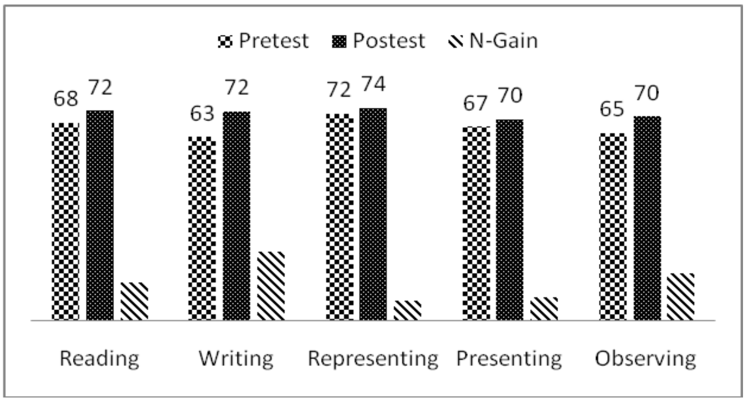

Fig 3. The score of scientific communication in control class

Unlike the experimental class, the average increase in N-Gain is low. From Fig 3, it is known that the highest improvement of the control class is the ability to write, then followed by the skills of reading, representation and presentation. Aspects of presentation and representation obtained the lower values than other aspects.

IV. Conclusion

The implementation of learning shows that the *production* model effectively help fostering the skills of scientific communication students to the medium level was based on the analysis of N-Gain. There is a significant increase between the skills of scientific communication students before and after the learning activities by implementing the *production* model based on a statistical test ($\alpha = 0,05$). Fostering of the scientific communication skills that implement the *production* model is better than that does not apply, as well as the consistency of the improvement almost evenly distributed to each school applying *production* model. Overall, the schools that apply the *production* model, the highest acquisition score is in the ability of representation and the ability to write in either category, and the lowest is the ability of observation and presentation with a good category.

Acknowledgements

Thanks to Prof. Dr. Rudiana Agustini for guidance and motivation given, as well as Higher Education which has provided centralized grant support in assisting this research and publication.

References

[1] NRC, *Assessing 21st Century Skills: Summary of Workshop. J.A. Koenig, Rapporteur. Committee on the Assessment of 21st Century Skills. Board on Testing and Assessment, Division of Behavioral and Social Sciences and Education* (The National Academies Press, Washington DC, 2011).

[2] Permendikbud 69 Tahun 2013 tentang Kurikulum Fisika SMA.

[3] Permendikbud 65 Tahun 2013 tentang Standar Proses Pendidikan.

[4] H. Turgut, Prospective science teacher's conceptualizations about project based learning. *International Journal of Instruction, 1(1)*, 2008, 61-79.

[5] W. Fadly, Profil of scientific communication in senior high school, *Jurnal Pendidikan Maja Vidya*, *2(1)*, 2013. 22-29.

[6] K. S. Taber, Conceptual resources for learning science: issues of transience and grainsize in cognition and cognitive structure, *International Journal of Science Education, 30,* 2008, 1027-1053.

[7] D. R. Baker, E.B. Lewis, S. Purzer, & M Lang, The communication in science inquiry project (CISIP): a project to enhance scientific literacy through the creation of science classroom discourse communities, *International Journal of Environmental & Science Education, 4(3)*, 2009, 259-274.

[8] J. R. Fraenkel, N. E. Wallen, *How to design and evaluate research in education (fifth edition). (*McGraw-Hill companies, New York, 2003).

[9] W. Fadly, *Production as physics learning model to improve scientific communication skills. Dissertation unpublished*. (State University of Surabaya, 2017).

[10] S. S. Gallagher, W. J. Stepien, & D. Workman, Implementing problem based learning in science classroom. *Scholl Science and Mathematic*, 95, 1995, 136-146.

[11] D. A. Pratiwi, *Pembelajaran berbasis masalah (problem based learning) dengan metode proyek dan resitasi ditinjau dari kreativitas dan konsep diri (self concept) siswa. Tesis tidak diterbitkan.* (Program Pascasarjana Universitas Sebelas Maret Surakarta, 2010).

[12] J. J. Chen, H. S. Lin, Y. S. Hsu, & H. Lee, Data and claim the refinement of science fair work through argumentation. *International Journal of Science Education, Part B, 1,* 2011, 147-164.

[13] R. Slavin, *Educational psychology theory and practice sixth edition* (Allyn and Bacon, Boston, 2006).

[14] A. Woolfolk, *Educational psychology* (Pearson Education, Boston, 2009).

[15] R. I. Arends, *Learning to teach* (Mc. Graw-Hill, New York, 2012).

[16] P. T. Ewell, Organizing for Learning: *A point of entr. draft prepared for discussion at the 1997 AAHE summer academy at snowbird* (National Center for Higher Education Management Systems (NCHEMS), New York, 1997).