The International Journal of Social Sciences and Humanities Invention 4(7): 3619-3624, 2017
DOI: 10.18535/ijsshi/v4i7.08 **ICV 2015: 45.28**
ISSN: 2349-2031

Research Article

Students' Argumentation Skills through PMA Learning in Vocational School

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Abstract: Physics is the basic of science that became the foundation for the development of technology. We can train our reasoning skills with learning physics. Reasoning skills are needed by humans to be able to create technology and make life easier. So, reasoning skills are very necessary for students in vocational schools to be able to develop skills based on the department. One of reasoning skills is argumentation skills. This research investigates the students' argumentation skills about the chapter of temperature and heat through PMA Learning. Quasi-experimental with post-test only control group designs was carried out for the research. The research samples were students of X-TKJ1 (experimental class) and X-MM (control class) at SMKN 2 Jember in the 2016/2017 academic year. The design of argumentation test was using the role of competing theories strategy. Based on the output of SPSS 23 with 2 samples independent test showed that the significant of the test was 0.000 < 0.05. The result of the test showed that the score of students' argumentation skills (about evidences and justifications of argument, counter argument, and rebuttal) in the experimental class are higher than those in the control class.

INTRODUCTION

Physics is the basic of science that becomes the foundation for the technology development. Physics learning enable the learners to train and increase the reasoning skills. Reasoning skills are needed by humans to able to create technology and make life easier. One of the reasoning skills is argumentation skills.

Physics learning is not only mastery of knowledge about facts, concepts or principles but also involves discovery process. Physics learning focused on problem-solving activities, understanding the concept, or science process skills. Through physics learning, students will be accustomed to think systematically and orderly structured because students are always faced problem solving, causality, questions and answers which are logical, scientific, and reasonable. Physics' problem solving is usually done systematically. Strong logic and argumentation skills will be very supportive of life as well as his career and his work later. Students will be more confident if they have good argumentation skills. Argumentation skills are very necessary for students in vocational schools to be able to develop skills based on the department.

Based on the Permendikbud No. 21 of 2016 [1] about Content Standard of secondary school, it is required that students have the thinking skills and scientific work competencies that must be possessed by students for secondary level such as ability to formulate problems, submit and test the hypotheses, determine variables, design and conduct experiments, collect and process the data, draw conclusions, and communicate in oral and written form. The argumentation skills are part of the communication skills. Based on that criteria, physics learning should be done to foster reasoning skills about natural events through creative thinking and critical thinking accompanied by communication skills through students' argumentation activities as part of science literacy and able to utilize society and its environment as learning resource.

Based on the assessment of PISA (Program for International Student Assessment) in 2015 the ability of science literacy of Indonesian students is ranked 69 out of 76 with an average score of 403. This value is still below the average compared to the world average 493 (OECD, 2016) [2]. Based on observations made in several vocational schools in Jember, such as SMKN 2 Jember and SMKN 5 Jember showed that the achievement of students' competence were not in accordance with the expected competence in the curriculum 2013. . The ability to communicate through arguing activities has not been trained. Teachers are still the center of learning, so the interest and motivation of students to learn are still low. The type of problem that can be achieved was only about the problem at levels 1 to 3. Whereas the ability to argue was at a matter of level 4 to 6. Based on the research conducted by [3] shows that the ability of respondents (students of SMK) to provided justification of arguments, counter arguments, and the rebuttal are still low. Based on the result of preliminary observation, there is a need of a model of learning that can develop and train students' argumentation skills and the Syntax of learning can meet the expected competence in the curriculum 2013.

The learning model was PMA (Penyelesaian Masalah Argumentatif) learning. PMA (Penyelesaian Masalah Argumentatif) learning is a learning model that can be used to develop and train students' argumentation skills. PMA (Penyelesaian Masalah Argumentatif) learning can train students' skill to write the arguments and improve students' learning outcomes [4]. PMA (Penyelesaian Masalah Argumentatif) learning has several advantages, such as being

able to train students' skills in obtaining, analyzing, and evaluating data into explaining the phenomenon of natural events scientifically; assist students in developing and using scientific thinking habits; understand the content of science; developing scientific argument skills; as well as providing opportunities for students to play a role in the science process [5].

The syntax learning of PMA (Penyelesaian Masalah Argumentatif) learning model consists of five phases. These five phases are designed to be related to one another. The phases in PMA (Penyelesaian Masalah Argumentatif) learning model include:

1) Identification of the problem. The problem is presented in the Student Worksheet in the form of competing theories strategy by giving 2 different statements to arouse students' curiosity to make them feel interested to find the answer.

2) Data acquisition. Students work in groups doing data acquisition activities that will be used to construct arguments, gather evidence to support the argument and answer the problems which are posed in the first phase.

3) Tentative formulation of the answer to the problem. Students must write a claim as a form of response to the problem posed in the first phase. Claims should be based on evidence of data which is obtained from the second phase and accompanied by scientific reasoning. The third phase was designed to emphasize the importance of scientific argumentation in science. This third phase was also to assist students in developing good arguments, determining whether evidence or data obtained can be used to support the claim.

4) Argumentation session. In this session, each group was given the opportunity to submit its claims and arguments to other groups and other groups will provide criticism or additions to the claims and arguments provided. Students will have the opportunity to evaluate and refine their claims and arguments through discussion activities.

5) Evaluation of the process and outcome of the problem solving designed to allow students to have the opportunity to provide feedback on the inquiry process and the agreed outcome of the problem. This phase was also designed to create an attitude of respect for evidence and critical thinking in the classroom and create a learning environment that requires students to be responsible for the quality of conclusions and agreed arguments (Supeno et al, 2015b: 73-75) [5].

Principles of reaction from the application of PMA (Penyelesaian Masalah Argumentatif) learning model include: teachers help students in reviewing problems that have been provided; teachers help students if students have difficulty in obtaining data or reviewing problems; teachers provide an evaluation of the problems experienced by students; and teachers help students in giving conclusions related to learning activities. The social system of the application of the PMA (Penyelesaian Masalah Argumentatif) learning model include: students collaborate in conducting experiments and obtaining data; students conduct group discussions to answer and solve problems; and students assisted by teachers provide conclusions with regard to learning activities. The implementation of the PMA (Penyelesaian Masalah Argumentatif) learning model will be accomplished better if there is a support system. The support system of the PMA (Penyelesaian Masalah Argumentatif) learning model is the Student Worksheet. The student Worksheet is designed in the form of competing theories strategy where in the Student Worksheet 2 statements are provided with contradictory meanings structured and equipped with guiding questions [5].

The application of the PMA (Penyelesaian Masalah Argumentatif) learning model provides instructional impact and accompaniment impact. The instructional impact of the application of the PMA (Penyelesaian Masalah Argumentatif) learning model can improve student learning outcomes and train students' skills in writing scientific arguments (Supeno et al., 2016). The accompaniment impact of the application of PMA (Penyelesaian Masalah Argumentatif) learning model for students are students have scientific experience by applying scientific method so that will be embedded meticulous attitude, honest, respectful attitude, respect for the opinions of others, the ability to gather information through various means and communicate [5].

According to [6] argumentation is a form of a statement accompanied by a reason that supports the statement. Important components of the argument include claims, data, evidence, support, qualification, and rebuttal. [5] argues that argumentation is a cognitive skill of students who can build conceptual understanding, understand the benefits of science, develop skills in researching and understanding the values of social interaction.

In this study, argumentation skills were measured using students' argumentation skills test. This test was modified using competing theories strategy. Research using tests equipped with competing theories strategy which has also been done by Acar and Patton (2012)[8]. On the test of the argumentation skill was given 2 different statements as a hypothesis that the students should be able to provide evidence and scientific explanation of the two hypotheses based on the experimental data. The Students Worksheet were structured and equipped with guiding questions so that the answers to the arguments given by the students in accordance with the desired situation of the teacher [5].

METHODOLOGY

The design used in this research is post-test only control group design. The subjects of the research sample were students at X TKJ 1 and X MM of SMKN 2 Jember. The object of the study is argumentation skills. The instrument in this study is a written test of argumentation that is used to know the students' skill of arguing after the physics learning with the PMA

learning. The given argument test is modified using competing theories strategy.

	Group	Dependent Variable	*Post test*
(R)	E	X	Y_1
(R)	K	-	Y_2

Table 1. The research design of post-test only control group design [9].

Explanations:

R : two groups of classes each selected randomly
E : experimental class (a class using PMA learning)
K : control class (classes using direct instructions learning)
X : treatment (in the form of use PMA learning)
- : treatment (in the form of direct instructions learning)
Y_1 : post-test results in the experimental class
Y_2 : post-test results in the control class

The results of the argumentation test are based on the scores obtained by the respondent against each indicator in the skill of arguing. Indicators of argumentation skills are as follows.

Table 2. Indicators of argumentation skills

Skills	Sub skills	Explanations
Argument	Evidences of argument	Accuracy in providing evidence of argument
	Justifications of argument	The accuracy and quality of students in explaining each argument
Counter argument	Evidences of counter argument	Accuracy in providing evidence of counter argument
	Justifications of counter argument	The accuracy and quality of students in explaining each counter argument
Rebuttal	Evidences of rebuttal	Accuracy in providing evidence of rebuttal
	Justifications of rebuttal	The accuracy and quality of students in explaining each rebuttal

As for the criteria of assessment on the test argument was as follows:

Table 3. Assessment criteria for evidences of argument and counter argument

Score	D
0	Without evidences or false evidence
1	There is wrong evidence
2	All the evidences are true

Table 4. Assessment criteria for evidences of rebuttal

Score	Descriptions
0	Without rebuttal and without evidences or false evidence
1	With rebuttal and without evidences or false evidence
2	With rebuttal and there is wrong evidence
3	Rebuttal and all the evidences are true

Table 5. Assessment criteria for Justifications of argument, counter argument, and rebuttal

Score	Descriptio
1,0	Without justification or false justification
2,0	Justification refers to observation and is not scientifically complete or has some correct scientific passage and a false scientific passage
3,0	Justification refers to observation and is scientifically correct

2 Samples Independent Test with SPSS version 23 software is used to analyze students' argumentation skills. As for the testing criteria of output from Independent sample t-test was as follows:

- If p (significance) > 0.05 then null hypothesis (H_0) is accepted and alternative hypothesis (H_1) is rejected. (The mean value of the students' argumentation skills of the experimental class is not different from the control class)
- If p (significance) ≤ 0.05 then null hypothesis (H_0) is rejected and alternative hypothesis (H_1) is accepted. (The mean value of students' argumentation skills of the experimental class is greater than the control class)

RESULTS AND DISCUSSION

Students' argumentation skills are measured through written tests. The test to measure students' argumentation skills in this

study was taken through post-test in the experimental class and control class. The following is the average of post-test score of students' argumentation skills in the experimental class and control class on Figure 1.

Figure 1. Students' Argumentation Skill at experimental class and control class

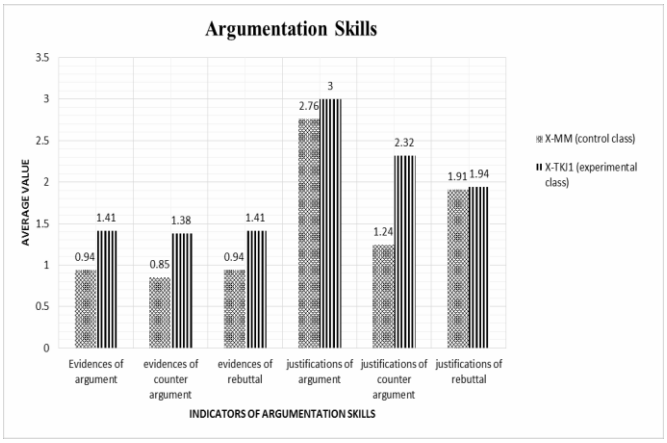
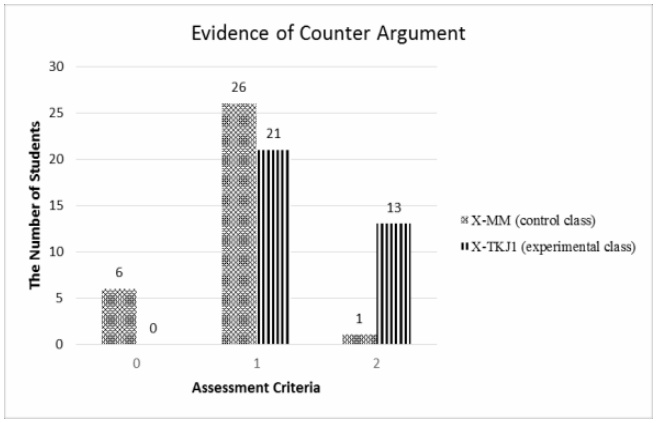
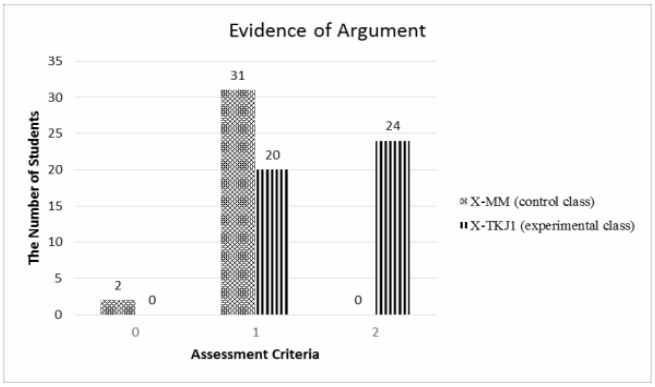


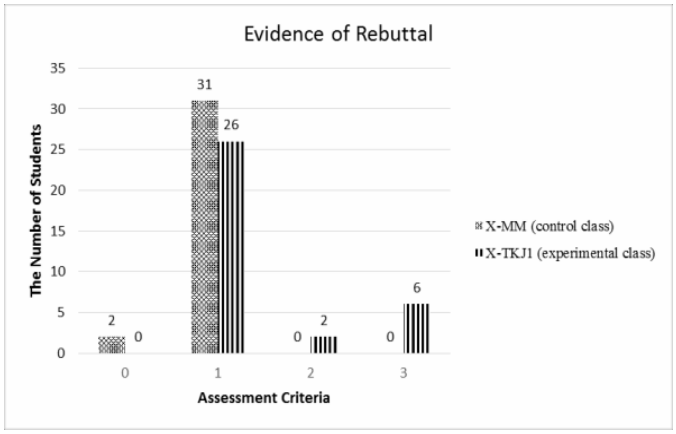
Figure 1 shows that the average of students' argumentation skills score in the experimental class was greater than the average of students' argumentation skills score in the control class students. In each indicator of argumentation skills (evidence of argument, evidence of counter argument, evidence of rebuttal, justification of argument, justification of counter argument, and justification of rebuttal) shows that the average score in experimental class was higher than the control class.





a)

(b)



(c)

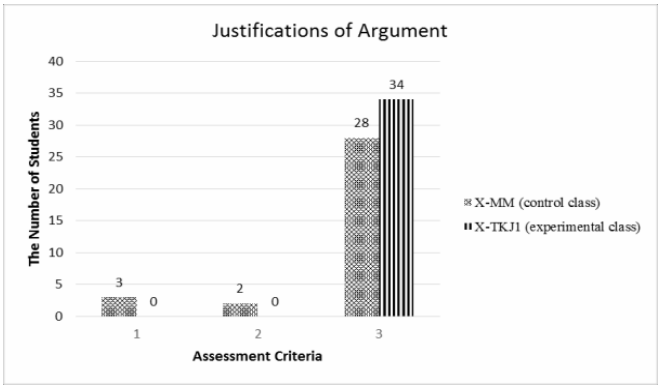
Figure 2. Skill of students at experimental class and control class in providing evidence of: (a) argument; (b) counter argument; and (c) rebuttal

The students' skill to provide evidence of argument can be seen on Figure 2a. The figure shows that most students in the control class can provide evidence of argument, but the evidence provided was still wrong. No one is able to provide evidence of argument correctly. While in the experimental class, all of students can provide evidence of argument. But some students are able to provide evidence of argument correctly and the other students can provide evidence but the evidence provided was wrong.

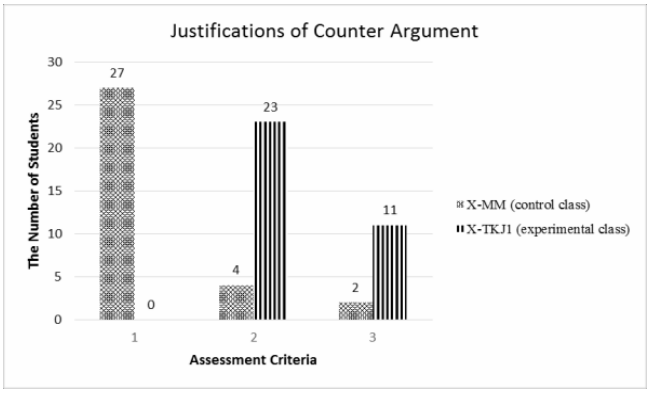
The skill of students in providing evidence of counter argument can be seen on Figure 2b. Most student in the control class can provide evidence of counter argument, but the evidence provided was still wrong and only a few can provide the evidence of counter argument correctly. While in the experimental class there is no one of students who are unable to provide evidence of counter argument. Some students are able to provide evidence of counter argument correctly.

Students' skill to provide evidence of rebuttal can be seen on the figure 2c. Most of the students in the control class can provide a rebuttal, but not accompanied by the evidence of the rebuttal and no one can provide evidence of rebuttal correctly. While in the experimental class there were some students who can provide a rebuttal but not accompanied by evidence and some students are able to provide rebuttal and evidence of rebuttal correctly.

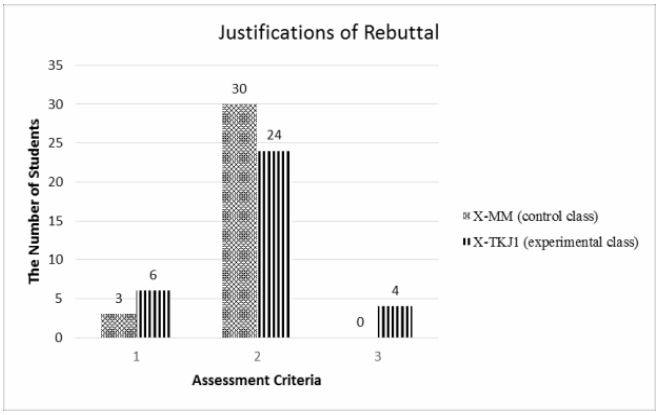
Figure 2 shows that students have good skills to give evidence of argument, counter argument and rebuttal. Students haven't difficulty in providing evidence because by conducting experimental activities, they can find evidence that supports their argument, counter argument or rebuttal. This is in accordance with the results of Supeno's research [4] that The student's skill to provide evidences are good through experimental activities.



(a)



(b)



(c)

Figure 3. Skill of students at experimental class and control class in providing justifications of: (a) argument; (b) counter argument; and (c) rebuttal

The students' skill to justify arguments can be seen on Figure 3a. Most of the students in the control class can provide justification argument by providing a scientific explanation in accordance with the results of observation, but there are students who are still not able to provide justification argument or justification given is still not complete. All students in the experimental class can provide justification argument by providing scientific explanation in accordance with the results of observation.

The students' skill to justify counter arguments can be seen on Figure 3b. Most of the students in the control class are not able to provide justification counter argument or justification given was still blurred. While some students in the experimental class can provide justification counter argument by providing a scientific explanation in accordance with the results of the observation. The reset of the students can provide justification counter argument but the scientific explanation of the results of observation is less complete.

The students' skill to justify rebuttal can be seen on Figure 3c. Most of the students in the control class have not been able to justify the rebuttal by providing a scientific explanation but less complete. While some students in the experimental class can provide justification rebuttal by providing a scientific explanation in accordance with the results of observation. The other students can provide justification rebuttal but the scientific explanation of the results of observation is less complete.

Based on the results of interviews to some students both in the experimental and control class shows that the students' biggest difficulty in the argumentative post-test is to provide a scientific explanation. Students have difficulty in giving scientific explanation because they do not study the subject matter as a whole by comprehending it completely so that difficulties when applied to the problem of reasoning. Learning in the control class also does not engage the ability to argue and no practical activities so that students have difficulty in solving post-test problems.

Results of interviews to some students after learning obtained that the learning by using the model of PMA to make students understand the subject being studied. Students practice to work together in groups. But sometimes students are confused in giving scientific explanation because not yet accustomed and student's previous learning is not trained to give scientific explanation at every phenomenon of natural occurrence. This is in accordance with the results of Supeno's research [4] and [11] that to develop knowledge in the process of argumentation takes a relatively long time. It needs to be trained continuously so that the ability to argue well.

Based on the normality test, it was found that the data of students' argumentation skills were not normally distributed. Then, test was done by using *nonparametric test - 2 samples independent test.* The output of *2 samples independent test* with SPSS version 23 found that significant value was 0.000 < 0.05. This means that the average value of students 'argumentation skill of the experimental class is greater than the average value of students' argumentation skill of the control class. Thus, argumentation skill using the PMA learning will be better.

The students' argument ability in the experimental class is greater than the control class because in the experimental class use the Argumentative Problem Solving (PMA) learning model during the learning activity. This is in accordance with the results of Supeno's et al. research,[5] that PMA (Penyelesaian Masalah Argumentatif) learning model helps students in obtaining, analyzing, and evaluating data to explain the phenomenon of natural events scientifically; Assist

students in developing and using scientific thinking habits; Understand the content of science; Developing scientific argument skills; As well as providing opportunities for students to play a role in the process of science. The results of Supeno, et al [4] showed that the learning environment created in the form of experimental activities in groups able to facilitate students in preparing arguments, argument proofs and justification Budiyono's research results [10] showed that the model- oriented argumentation of students have a good impact on the ability Argue students.

CONCLUSION

Based on the result of the research, it can be concluded that the students' argumentation skills on physics learning on the subject of temperature and heat in Vocational School can be improved by using the PMA (Penyelesaian Masalah Argumentatif) learning model. The other researchers can use Penyelesaian Masalah Argumentatif (PMA) learning in the classroom to train reasoning skills. Training reasoning takes a long time and constantly. The reasoning skills was very important for students in vocational school when it has entered the workforce. Practical activities can be done using virtual practicum because of the limited tools and the number of hours of study. In addition, it is necessary to examine the students' skills to uncover arguments verbally during the discussion process with other subjects.

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