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STUDENTS' SCIENTIFIC EXPLANATION IN BLENDED PHYSICS LEARNING WITH E-SCAFFOLDING

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ABSTRACT

This purpose of this research was to analyze the influence of blended physics learning with e-scaffolding on the gas kinetic theory to the students' scientific explanation. This research used quasi-experimentation with one group pretest-posttest design. The population of this research included the grade XI students of Natural Sciences in SMA Negeri 1 Bangkalan. The proposed hypothesis was that the blended physics learning with e-scaffolding affected the students' scientific explanation. The research results indicated that the students' scientific explanation ability significantly increased after they experienced blended physics learning with e-scaffolding. All aspects of scientific explanation, that was the claim, evidence, and reasoning improved significantly.

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Keywords: blended learning, e-scaffolding, scientific explanation

INTRODUCTION

The innovation in learning should be carried out to improve the low category of the evaluation test referring to the result of PISA Indonesia 2015. One of the ways to increase the score of PISA is growing the competency of arguing or giving a scientific explanation. Besides, the learning in Indonesia that applies 2016 National Curriculum (revised version of 2013 Curriculum) also intends to implement the scientific approach that cannot be separated from the scientific investigation and demands the good scientific explanation ability.

Engaging students in scientific practice may help refine their viewpoint of science or physics. Helping students engage in scientific practice may shift their view of science as a static set of facts to science as a social process in which knowledge is constructed. Furthermore, assisting students to construct a deeper understanding of content knowledge would engage them in scientific explanation (McNeill &Krajcik, 2008). As an argumentative practice, engaging science learning could promote students' critical thinking, reflection, and evaluation of evidence (Bathgate et al., 2015). Besides, the scientific competencies proposed by PISA focus on the ability needed in students' life in accordance with students' involvement in giving the scientific explanation.

Wang (2015) stated that one of the primary purposes of science education is preparing the students to synthesize and evaluate the scientific explanation. Meanwhile, the scientific competencies suggested by PISA focus on the ability needed in the students' life. Tsai (2015) has investigated how such scientific competency can be improved using online argumentation. The research results showed that the use of online argumentation could enhance the students' scores in the scientific competency of PISA. Argumentati-

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on teaching consisting of specific process, online assistance and scenario of argumentation conflict can help upgrade the students' scientific competencies of PISA.

The microanalysis of student discourse by Von Aufrchnaiter et al. (2008) showed that: (a) students draw on their prior experiences and knowledge when engaging in argumentation; (b) such activity enables students to consolidate their knowledge and elaborate their science understanding at relatively high levels of abstraction. The results also suggest that the students could acquire a higher quality of argumentation consisting of well-grounded knowledge with a relatively low level of abstraction. Furthermore, the findings indicate that the primary indicator of students' familiarity and understanding of the task content determine whether a high quality of argument is likely to be attained or not. The implication of developing argumentation in the classroom is needed to consider the nature and extent of students' content-specific knowledge, also, their experiences before asking them to engage in argumentation.

Braaten&Windschitl (2011) argued that the conceptualization of a clearer scientific explanation for science education is essential to realize the vision of science education reform. Therefore, by improving the scientific explanation ability, the score of PISA could increase.The scientific explanation framework includes three components, namely claims, evidence, and reasoning. The claim makes a statement or conclusion that addresses the original question or concerns about the phenomenon. Evidence supports student claims using scientific data. Data can be obtained from investigations or from other sources, such as observation, reading material, or archival data, and the need to be precise and sufficient to support such claims. Reasoning connects claims and evidence and shows why data is counted as evidence to support the claim. When making this connection, students must often use the precision of scientific principles.

The physic learning relevant to the nature of Natural Sciences needs an inquiry process. This process enables students to directly involved in a learning process. Through this activity, it is expected that students acquire scientific attitudes and after passing a sequence of learning, students could make their own conclusion. The scientific explanation a teacher presents may vary in its implementation. This would determine the practicum quality done by students. The instructional practices conducted by teachers could influence scientific explanation learned by students (Berland&Reiser, 2009). The scientific investigation usually involves relevant evidence, logical reasoning, thoughts in arranging the hypothesis, and the explanation to understand the collected proofs.

Problem Based Learning (PBL) is a learning model designed to solve the presented problems. According to Arends (2012), PBL is a learning model that exhibits various authentic and meaningful problems for students, functioning as a stepping stone for investigation. The PBL model is a learning model that helps students develops their activeness in an investigation. Besides, the PBL model could develop thinking skill to solve the problems.

Based on the explanation from some experts, it concluded that the characteristic of such learning model emphasizes on the problem-solving. The problems should be ill-structured and contextual. Students are demanded to actively search the information from all sources related to the faced problems. The analysis results are later referred to as the problem solution and communicated to others.

To facilitate students in searching for information, PBL could be combined with online learning. This combination may support students to be more active in finding a solution. A learning program that mixes traditional in-class learning components and e-learning components is called hybrid learning or blended learning (Kim, 2008).

Some benefits of blended learning are its potential to bring out the variations of learning style, enrich the learning experience, and increase the consistency of topic and quality of given training. Blended PBL model is one of the blended learning models in the physics learning that has those benefits. Thereby, the goal of improving the scientific explanation ability could be accomplished through blended physics learning activities.

The term scaffolding was introduced by Wood, Bruner, and Ross in 1976 which means mentoring or another assistance given in the learning setting to help students reach an understanding sequence that is impossible for them to achieve without help (Raes et al., 2012).

The way to facilitate various levels of students' pre-conception in a class called scaffolding. The scaffolding between different ability levels of students would have differential impacts (Belland et al., 2011). Procedural scaffolding is assistance utilizing the available resources and tools (Yu et al., 2013). External scaffolding may be the way of supporting students' construction of evidence-based arguments (Belland et al., 2008).

Procedural Scaffolding helps the students use the resources. It reduces the cognitive load, enables participants to focus on the task rather than investing the cognitive resources in the mechanism of procedure and navigation. The assisting system in Microsoft Word, for example, enables students to search the information in a specific function and the link of the related field and gives the "office assistant" identifying the steps needed to operate the program features. The navigation map found on many Web pages is procedural scaffolding (Grabe&Grabe, 1998).

Besides, the technology always rapidly escalates and influences the human's life very much. For instance, the diverse kinds of technology employed to support the human's life sustainability in 2000 decades develop fast to be more complicated as faced today. The technology development also impacts many fields such as health, economy, social and culture, information and communication, education, and the others.

E-scaffolding in this research is a virtual collaborative and comprehensive learning tool. This media can facilitate the collaboration of small duty until long semester-task among students in a class, with students from different schools, between students and teachers, as well as between teacher and teacher via the internet. From 118 scaffolding occurrences noted, the majority of assistance are procedural and conceptual (Way & Rowe, 2008). These are the differences of this research from the previous studies; the concept of procedural e-scaffolding applied in blended PBL model will be able to train and improve the students' scientific explanation ability.

Mustajab & Sahala (2014) stated that one of the physics sub-materials in physics lessons is the ideal gas. This ideal gas sub-materials is abstract and frequently cause errors in solving the ideal gas problems. A research conducted by Mahmudah (2013) on 10 students of XI IPA Grade in SMA Negeri 7 Surakarta, the academic year 2012/2013 found the kind of mistakes made by the students in solving problems on the subject matter of gas kinetic theory; 56% of it was concept errors and 44% of it was miscalculations. Yoto (2015) stated that gas kinetic theory is abstract and microscopic. Similarly, the scope of this study relates to invisible objects. Therefore, learning the kinetic theory of gas in SMA should be supported by the media that could help students understand the materials so that reasonable scientific explanation is obtained. Therefore, an appropriate learning strategy is needed to learn the material of gas kinetic theory. In short, this research aimed to analyze the students' scientific explanation ability after experiencing blended physics learning with e-scaffolding.

METHODS

This study was quasi-experimental research using only experimental class for the research without control class. The research design used was One Group Pre-test – Posttest Design. In this design, the observation was conducted twice; before the experiment (pre-test) and after the experiment (post-test). The populations of this research were the XI IPA students in SMA Negeri 1 Bangkalan and one class as the research sample. The following is the design adopted in this research.

$$Y_1 \longrightarrow X \longrightarrow Y_2$$

(Sudjana & Ibrahim, 2001:35)

Note:
Y_1: Giving pre-test
Y_2: Giving post-test
X: The type of treatment

In this stage, the improvement of students' scientific explanation ability was measured through the pre-test and post-test, before and after implementing the blended physics learning with e-scaffolding. The instruments used were in the form of questionnaire test made up of ten questions. After going through the empirical test process, the ten questions were declared valid and reliable. Thus, the ten questions were tested during a scientific explanation test.

The N-gain Score

The data of pre-test and post-test were analyzed using n-gain score (the normalized gain). The interpretation criteria of the normalized gain score are presented in Table 1.

Table 1. The Criteria of Interpretation of Normalized Gain Score

Score	Interpretation
≥ 0,7	High
0,7 >≥ 0,3	Moderate
< 0,3	Low

(Hake, 1998)

The T-gain Test

The t-gain test was used to know the significance of the students' scientific explanation skill improvement after experiencing the blended physics learning with e-scaffolding. The analysis results of the t-gain test were obtained by analyzing the results of pre-test and post-test. The steps to analyze the t-gain according to Arikunto (2010) are as follow:

1. Arranging the hypothesis
2. H_o: the improvement of the students' scientific explanation ability is not significant
3. H_1: the students' scientific explanation ability increases significantly
4. Determining the gain score (d) by finding the difference between the results of post-test and pre-test
5. Determining the gain mean (Md)
6. Determining t score.
7. Drawing the conclusion of tcount and ttable at the significant level of 0.05. If the $t_{count} < t_{table}$, the Ho is accepted and if the $t_{count} > t_{table}$, the Ho is rejected.

RESULT AND DISCUSSION

The results of pre-test showed the students' pre-conception in the domain knowledge. After having the pre-test, the students experienced the blended learning with e-scaffolding for Gas Kinetic theory. At the end of learning, the post-test was conducted and the scores were gained. Pre-test and post-test scores are presented in Table 2.

From Table 2, it knows that the pre-test mean of students' claim was 53, the pre-test mean of evidence was 49, and the pre-test mean of reasoning was 43 so that the mean of the students' pre-test scores was 48. The Table 2 also indicated that the post-test mean of the students' claim was 89, the post-test mean of evidence was 85, and the post-test mean of reasoning was 80 so that the mean of the post-test scores was 85. These scores increased from pre-test for all aspects of the claim, evidence, and reasoning to the final scores.

Subsequently, the results of pre-test and post-test were analyzed using the n-gain scores to know the improvement of the students' scientific explanation and all aspects measured through pre-test and post-test before and after learning. The analysis results of the n-gain scores showed the significant improvement in all aspects of students' scientific explanation. The n-gain score for the claim, evidence, and reasoning was 0.77, 0.71, and 0.65 respectively. The n-gain score for the scientific explanation was 0.71. Based on Table 1, all improvements were considered high except for the reasoning.

Table 2. The Students' PreTest and Post-Test Scores on Scientific Explanation

The Test Results of Scientific Explanation	Pre-test							Post-Test						
	Score			Value			FS	Score			Value			FS
	A	B	C	A	B	C		A	B	C	A	B	C	
Mean	16	15	13	53	49	43	48	27	25	24	89	85	80	85
SD	6,2	3,2	3	21	11	10	11	2,9	3,3	3,4	9,8	11	11	8,3
Maximum	29	20	20	97	67	67	74	30	30	30	100	100	100	100
Minimum	10	10	10	33	33	33	33	22	20	19	73	67	63	68

Note: A = Claim; B = Evidence; C = Reasoning; FS = Final Score; SD = Standard Deviation

The results of pre-test showed that the students' mean for each indicator of scientific explanation was still low which are the mean of claim (53), the mean of evidence (49), the mean of reasoning (43), and the final mean (48). From those three indicators, the mean of claim was the highest score compared to the other two indicators. This case showed that the students have not been able to give a statement of answer, present and show the evidence to support their statement of answer, and relate the understanding of the topic to the obtained evidence to support their answer in the reasoning part. Thereby, the results of pre-test indicated that the students' scientific explanation ability was less good. For the students to be able to complete the performance better, helping students understand the rationale behind a particular scientific inquiry practice is important in science (Mc Neill &Krajcik, 2008). Mc Neill (2011) investigated students' views of three contexts of explanation, argument, and evidence. When they were asked about their science class, most likely answered 'I don't know'. Even though they had enough learning sources both from everyday knowledge and scientific knowledge, they were unsure how to use the sources in their science class. Therefore, building the explanation means showing the ability to provide the right explanation and understanding equipped with the evidence.

The post-test results after treatment showed that the mean of claim indicator increased to 89, the mean of evidence indicator also enhanced to 85, and the mean of the students' reasoning also improved to 80. This indicates that the final mean of the students' scientific explanation also upgraded to 85. The results of the t-gain test showed that there was a high and significant scientific explanation ability of the students.

The post-test result after the treatment of e-scaffolding in blended learning supported the students to learn independently and collaboratively. E-scaffolding individually bridged the students' zone of proximal development with the faced challenge. Besides, e-scaffolding guided them in group and face-to-face learning.

There are some research findings supporting this research results. Kim et al. (2017) found that students who learned with the scaffolding assisted by a computer in PBL context had better performance than those who did not use scaffolding. Supporting students in writing scientific arguments to explain phenomena were more successful by the context-specific curricular scaffolds, but only if teachers' provided explicit general domain for the framework of claim, evidence, and reasoning (Mc Neill &Krajcik, 2009). Yu et al. (2013) revealed that the use of procedural scaffolding supports students in the learning activity. Those who used procedural scaffolding gained better outcome than those who did not (Yu et al., 2013). Amelia et al. (2016) also showed that the procedural scaffolding applied in specific class could enhance the learning achievement. Hsu et al. (2015) told that scaffolding is very helpful for the process of investigation and development of conceptual understanding.

CONCLUSION

Blended physics learning with e-scaffolding improved the students' scientific explanation. The improvement occurred in all aspects of scientific explanation namely claim, evidence, and reasoning. The highest improvement occurred in the claim aspect. These two aspects, claim and evidence, grew significantly through collaborative activities in solving problems. In these activities, students were required to seek information and analyze them actively then communicated the solution. In the blended physics learning with e-scaffolding, the students involved in supportive activities to help them in finding the solutions. Therefore, it is suggested that teachers should develop collaborative and supportive activities in physics learning such as blended learning to enhance students' scientific explanation.

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