The Effectiveness of Scientific Approach Using E-Module Based on Learning Cycle 7E to Improve Students' Learning Outcome

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ABSTRACT

The application of scientific approach in the student-centred learning process requires the role of the teacher as a facilitator to support the creation of active learning by using a variety of media. One way to create such learning is to use e-module media based on learning cycle 7E. The purpose of this research was to find out the effectiveness of scientific approach by using e-module based on learning cycle 7E on high-school-students' learning outcomes. The research was an experimental research using one-group pretest-posttest pre-experimental design. This study used a sample of Mathematics and Science (MIA) students of Senior High Schools in Karanganyar Regency, Central Java, Indonesia. The sampling technique used was purposive sampling while the data-collection technique was using test, that are pre-test and post-test. The data test were then analysed using t-test (Independent Simple t-test) with SPSS 17.0. The results of the analysis showed that the application of scientific approach using E-Module based on learning cycle 7E is effective to use.

Keywords:[1]
Scientific Approach, E-Module, Learning Cycle 7E, Learning Outcome.

INTRODUCTION

The development of science and technology has positive effects on various sectors especially in providing convenience, not least in education (Warburton, 2003). Therefore, the utilization of technology in education, especially in the learning process will provide ease, such as the utilization as learning media (Açişli, Yalçin, & Turgut, 2011; Warburton, 2003). Learning media can be used as an intermediary in bringing information in the form of the text, audio, or video between the giver (the teacher) and the recipient (the student) of the information in the learning activities (Buckingham, 2002; Smaldino, Russel, Heinich, & Molenda, 2005). The use of learning media aims to improve and simplify the learning process so that optimal results can be obtained (Conway, 2011; Siqueira, Berardi, Mistry, J., & Rothberg, 2016). But in fact, the use of learning media is still minimal in the learning process. Most teachers provide learning by lecture method so that the implementation of teacher centered learning. The implementation of such learning has an impact on the low student learning outcomes. Based on data student learning outcome from the semester exam in the academic year 2017/2018 can be seen in the following figure:

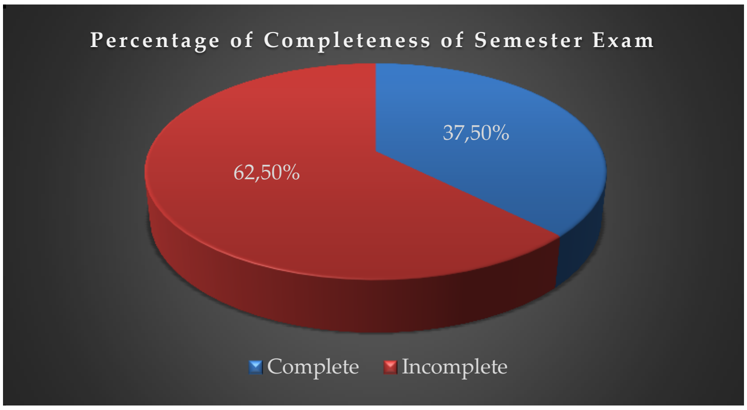

Figure 1: Students' Learning Outcome From The Semester Exam

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Figure shows that most of the students on the exam is unfinished semester of 62.50%, while the students who passed the exam is only 37.50%. this figure indicates that the learning process that takes place in the class is not optimal so that the results obtained are also low. According to Kettunen, Kairisto-Mertanen, & Penttilä (2013) states that Learning outcomes provide a general statement of the results obtained during the learning process undertaken by students. Learning outcomes are the ultimate goal to achieve as the manifestation of change after going through a long process of teaching and learning activities, This is reflected in the scores obtained in the cognitive, affective, and psychomotor aspects (Rusman, 2014; Tagg & Tagg, 2014; Watson, 2002). Student learning outcomes can be influenced by several factors either from internal factors such as intelligence, talent or student interest in learning, as well as external factors such as environmental conditions, models, or learning media used (Mulyanto, Gunarhadi, & Indriayu,2018).

Related the problem, efforts to improve learning can be done externally with the teacher to update the learning is mainly related to efforts to improve student learning outcomes are low. There are various ways that can be done by the teacher, one way is implementation of scientific approach. The scientific approach is a learning process that has the characteristics of "doing science" with activities designed in such a way with the aim that students are able to build and develop concepts, theories, laws or principles through the implementation of five stages systematically consisting of (1) "Observe", observation, (2) "Ask", formulating the problem through questioning and constructing hypothesis by developing and making a model, (3) "Gather information", collecting data or references in various ways that can lead to the discovery of facts or concepts, for example by investigating, (4) "Associate", analysing and managing, summarizing data; and (5) "Communicate", communicating information and conducting an evaluation (Hosnan, 2014; Laverty et al., 2016; Meyer, Capps, Crawford, & Ross, 2012; Prakoso, Fitrayati, & Dewi, 2018). Activities undertaken at each stage provide an active student opportunity so that the learning process takes place in student centered learning. In addition, the application of scientific approach can be supported by using learning media so that the material learned more easily understood students.

E-module is one of the media that previously printed media changed into new module form, electronic module, with the use of technology (Sugihartini et al., 2017; Voithofer, 2005). E-module is an Information and Communication Technology (ICT) -based module that has interactive properties due to the ease of navigation, display of images, audio, video, and animation that provides variation, as well as feedback through specified formative tests or quizzes (Sugihartini et al., 2017; Voithofer, 2005). the exciting e-module display provides an attraction for students in learning the material. the use of media can be collaborated with the learning model so that the results obtained more optimal. one of the learning model that can be used is learning cycle 7E (Elicit, Engage, Explore, Explain, Elaborate, Evaluate, Extend). This model is based on the constructivism theory of Vygotsky, Piaget, Bruner, and Dewey(Arends, R. I. & Kilcher, 2010; Sugiyanto, 2010). This model is also considered appropriate to be applied in the learning process with a scientific approach because the learning activities are more student-centered (Sornsakda, Suksringarm, P., & Singseewo, 2009). The learning cycle is a learning model with a series of systematic activity stages organized to assist students in acquiring concepts to master established competencies (Nuhoğlu & Yalçın, 2006).

Based on the problems that occur about the low learning outcomes of students, then the implementation of scientific approach use of E-module media based on learning cycle 7E can improve learning outcomes. This is evidenced by the research that has been done by Ghaliyah, Bakri, & Siswoyo (2015) stating that the implementation of e-module based on the learning cycle 7E can improve student learning outcomes because the contents of the module is more interactive with the animation, audio, and video so that students are easy in understanding the material and ultimately the achievement of learning outcomes more optimal. Thus, this research is conducted to find out how the effectiveness of the application of scientific approach by using e-module media based on learning cycle can improve student learning outcomes.

METHOD

This research was a quasi-experimental research with matching-only pretest-posttest control-group design (Fraenkel, J. R., Wallen, N. E., & Hyun, 2012). It was conducted with pre-test implementation before the post-test was given to find out the results of the treatment and become a benchmark before and after the treatment (Cresswell, 2008) (Cresswell, 2008). This research was conducted in Karanganyar Regency, Central

Java Province, Indonesia. The sample used in this research are the students of Mathematics and Science (MIA) group in the tenth grade of 104 students. As many as 32 students will be involved for the instrument trial and 72 students as subjects who were subjected to treatment and did not experience the subject. Therefore, 72 students were grouped into two using the random-stratified random sampling technique by calcifying on the basis of ladder and then class selection used in the research by drawing (Fraenkel, Wallen, Hyun, 2012). Based on the draw taken then determined both groups were the experimental group (treated) and the control group (not treated).

Material

The data collection is done by implementing the learning in two different groups namely, the experimental group and the control group. The treatment given was the application of scientific approach with e-module media based on learning cycle 7E. The application of this treatment was given in four meetings. The procedures of applying scientific approach by using e-module media based on learning cycle 7E can be seen in the following table:

Table 1: The Scheme of Applying Scientific Method Using E-Module Based on Learning Cycle 7E

Scientific Approach	E-Module Based on Learning Cycle 7E
Observe	1. "*Elicit*" - Making an initial understanding by providing material-related images.
Ask	2. "*Engage*" - arousing interests by stimulating thinking skills through the questions asked.
Gather information	3. "*Explore*" - observing the data by doing projects in groups. 4. "*Explain*" - students present the findings of the project they did with their teams.
Associate	5. "*Elaborate*" - encouraging students to build new understanding through classroom discussions.
Communicate	6. "*Evaluate*" - evaluating students' learning outcomes. 7. "*Extend*" - a discussion by linking the theory and the problems in life.

(Source: Eisencraft (2003); Nuhoğlu and Yalçın (2006); The Regulation of the Ministry of Education and Culture (2013); Balta dan Sarac (2016))

The data were collected using tests performed on the learning process both before and after. Pretest-posttest questions were given to measure learning outcomes during the learning activities that have been implemented (Majid, 2013). The number of items of the pre-test and post-test used in this research was 40. Before being used, the test-items were tested (tests of validity, reliability, discriminating power, and difficulty levels) to obtain the feasible items for the research (Budiyono, 2015). Validity is the most critical criterion and indicates the extent to which the instrument can measure what should be measured, while the reliability test is the measurement of the instrument to see the reliability of the instrument in delivering consistent results over time (Howitt & Cramer, 2011; Khotari, 2004). Because the the students' abilities are different, the discriminating-power test was conducted so that the test-items used can distinguish the students with high abilities and those with low abilities (Budiyono, 2015; Sundayana, 2014). In addition, the test of the difficulty levels of the items mentioned aimed to find out the students' levels in doing the test, whether the items are easy, moderate, or difficult (Arikunto, 2013; Sundayana, 2014). The analysis of validity, reliability, discriminating power, and difficulty levels conducted with SPSS 17.0 showed that 30 out of 40 items were considered suitable for use in the research.

Analysis Data

Analysis of test data using t-test (Independent Sample T-Test) with the help of SPSS 17.0. the results of data analysis is done to determine the effectiveness of the media used in the application of scientific approach by looking at the value of significance. If the value of significance (Sig> 0.05) means H_0 is accepted, H_1 is rejected or the resulting significance value is less than 0.05 (Sig <0.05) which means H_0 is rejected and H_1 is accepted. The decision-making requirements are:

H_0 : there is no difference in learning outcomes between the experimental group and the control group.

H_1 : there are differences in learning outcomes between the experimental and control groups.

FINDINGS

The study was conducted by testing both groups, the experimental and control groups. The test was conducted in two classes; they are class X MIA 3 as the experimental group and class X MIA 4 as the control group. Both groups were given pre-test initially as a reference for the researchers to know the students' abilities at the beginning of learning. If the test results of both groups were the same, treatments could be given. Both groups were given different treatments. The treatment given to the experimental group was by using e-module based on learning Cycle 7E model while the control group did not get the treatment which means that the implementation of learning was done conventionally. In the control group, learning activities were conducted using lecture methods in the delivery of materials and the formation of small discussion groups. During the learning process in the control group implemented without the use of instructional media.The learning was conducted in four meetings. While in the experimental group, the learning activities were conducted in accordance with the scientific approach (1)"Observe" observation, (2)"Ask", formulate the problem through the question, compile the hypothesis by developing and forming the model, (3) "Gather information" Collecting data or references in various ways that may lead to the discovery of facts or concepts, for example by investigating, (4)"Associates" analyzing and managing, summarizing data; and (5) "Communicate" conveys the information the student has obtained. In addition to the implementation of these activities, the learning that took place in the experimental group will be aided by the use of learning media that is e-module based learning cycle 7E.

The learning in both groups was conducted in four meetings and each meeting lasted for 135 minutes.. At the end of the meeting, a post-test was given. It was given to measure the students' achievements during the learning process. Before testing the effectiveness of the product, it is necessary to test the the analysis prerequisite of the data of students' learning outcomes. The following is the results of the analysis-prerequisite test and the effectiveness of the product:

Normality test

This test was conducted to find out whether the sample data used came from a normally-distributed population or not. The statistic-test used was Shapiro-Wilk test with SPSS 17.0 and the significance level was α = 0,05. The decision-making requirements are:

H_0: the sample is normally distributed

H_1: the sample is not normally distributed

The requirement of H_1 acceptance and H_0 rejection was when the significance value was greater than 0.05 (Sig > 0.05). In contrast, H_1 was rejected and H_0 was accepted if the probability value or significance value was less than 0.05 (Sig < 0.05). The translation of normality test against pretest data in experiment and control group can be seen in the following table:

Table 2: The Normality Test of Pre-test of the Experimental and Control Groups

Groups	Shapiro-Wilk[a]	
	df	Sig
Experimental	36	0.084
Control	36	0.144

Based on the above **table 2**, it can be concluded that the significance value obtained from the experimental group was 0.084 and from the control group was 0.144. The results showed that the singularity value of the pre-test data of each group was greater than α (sig > 0.05) meaning that H_0 is accepted and the data represent the normally-distributed sample.

The normality-test results of the post-test data of the experimental and control groups in both schools can be seen in the following table:

Table 3: The Normality Test of Post-test of the Experimental and Control Groups

Groups	Shapiro-Wilk[a]	
	df	Sig

Experimental	36	0.264
Control	36	0.192

Based on the **table 3** above, it was found that the significance value of the experimental group was 0.264 and of the control group was 0.192. Both groups obtained a significance value greater than α (sig > 0.05) meaning that H_0 is accepted and the post-test data are normally distributed.

Homogeneity Test

The homogeneity test was conducted to find out whether the sample came from a homogeneous population or not. The statistical test applied Levene Statistic with SPSS 17.0. The requirements for hypothesis drawing are:

H_0: the data is not homogeneous

H_1: the data is homogeneous

The decision making of the homogeneous-test results indicated that the data were homogeneous. H_1 is accepted if the significance value is greater than 0.05 (Sig. > 0,05) and the data are not homogeneous when H_0 is accepted and H_1 is rejected i.e. the significance value is less than 0.05 (Sig. < 0.05) and otherwise H_0 is rejected. The homogeneity-test results can be seen in the following table:

Table 4: The Homogeneity Test of the Experimental and Control Groups with Levene Statistics

Data	***Levene statistics***	**df1**	**df2**	**Sig.**
Pre-test	0.133	1	70	0.716
Post-test	0.585	1	70	0.447

Based on the **table 4** above, it can be concluded that the data are homogeneous because the significance value of the pre-test data is 0.133 and that of the post-test data is 0.585, both of which have greater value (Sig. > 0,05) or H_0 is rejected H_1 is accepted.

The statistical prerequisite test that has been done has fulfilled the requirement that the sample data are normally distributed and homogeneous. Then, t-test can be applied to the research data. The use of t-test was done with the independent sample t-test because this study used two different groups namely the experimental and the control groups. Furthermore, both groups were compared to see the mean difference before and after the treatment. The following is the result of the Independent sample t-test on the pre-test and post-test data of both groups:

Pre-test Data

The mean score of the pre-test data between the experimental and the control groups can be seen in the figure below:

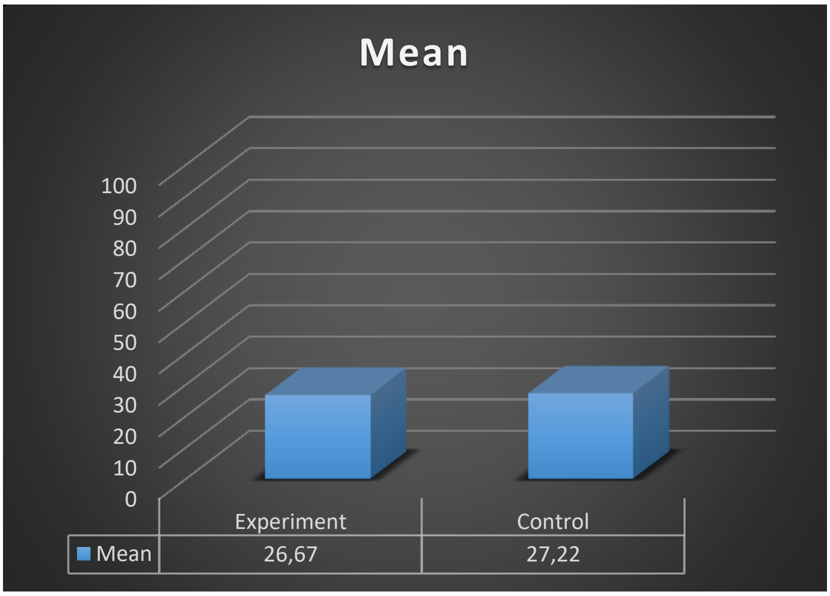

Figure 2: The Mean-Score Difference on the Pre-test of the Experimental and Control Groups

Based on **figure 2** above, it can be seen that both groups have the same mean difference. The experimental group obtained 26.67 and the control group obtained 27.22. This is evidenced by the test (Independent Sample t-Test) of the pre-test data with the following hypothesis:

H_0: there is no mean difference between the experimental and the control groups
H_1: there is a mean difference between the experimental and the control groups

The following is the data description of the pre-test results with SPSS 17.0:

Table 5: The t-Test of Pre-test Data

Data	df	Sig.
Pretest	70	0.716

Based on table 5 above, it is concluded that H_0 is accepted and H_1 is rejected which means that there is no significant difference in the mean on pre-test from the experimental or control groups.

On the other hand, the post-test data showed that both groups have different mean scores which can be seen from the figure below:

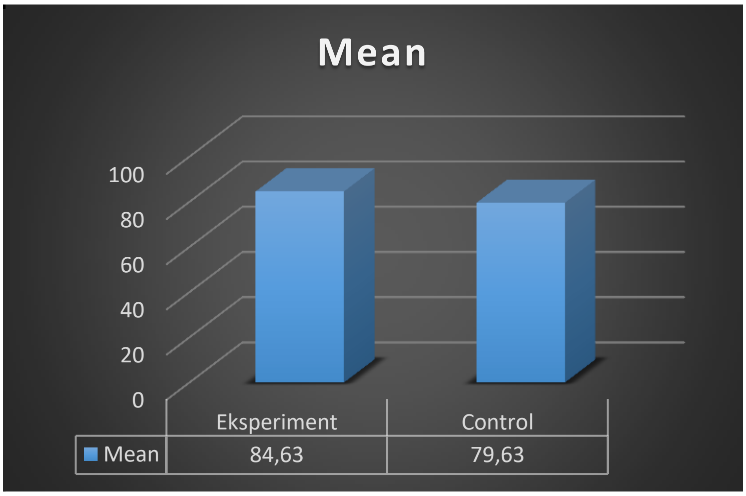

Figure 3: The Mean-Score Difference on the Post-test of the Experimental and Control Groups

Based on the **Figure 3**, it can be seen that the post-test score of the experimental group is 84,63 while of the control group is 79,63. The mean difference between the two groups is also supported by the test results (Independent Sample T-Test) in the following table:

Table 6: The t-Test of Post-test Data

Data	**df**	**Sig.**
Post-test	70	0.002

Based on the table, it can be concluded that there is a significant difference on the mean post-test scores of the experimental and the control groups because H_0 is rejected and H_1 is accepted by viewing the significance value of $0.002 < 0.05$.

The advanced test that can be done is to look at N-Gain data to find out how much change occurred on the treatment. Changes that occur to benchmark the effectiveness of the application of scientific approach by using e-module based on learning cycle 7E to improve learning outcomes. The following is the description of N-Gain test data:

Table 7: The t-Test of N-Gain Data

Data	**df**	**Sig.**
Gain	70	0.000

Based on the above data, it can be concluded that H_0 is rejected and H_1 is accepted because it has a significance value of $0,000 < 0.05$ which means there is a significant difference in the learning outcomes between students who were given treatment (experimental group) and those who were not (control group). This is evidenced by the results of pretest-posttest showing that the average student learning outcomes increased after learning. The improvement of the students' learning outcomes can be seen in the following figure:

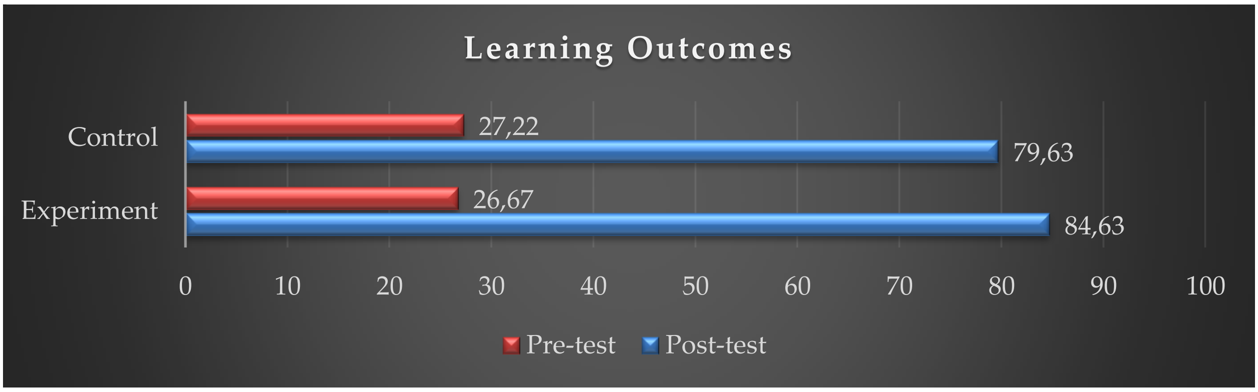

Figure 3: Learning-Outcome İmprovement of The Experimental and Control Groups

Based on the **Figure 3**, it can be seen that the students' learning outcomes obtained from the pretest-posttest scores increased differently between the experimental and control groups. In the experimental group, the pre-test result was 26.67 before learning. The score increased at the end with the post-test score of 84.63. On the other hand, the pre-test score of the control group was 27.22 which increased to 79.63 in the post-test. The pretest-posttest scores of the experimental group increased up to 57.96 whereas the score increase in the control group was 52.41. Thus, the improved learning outcomes indicates that the experimental group is better than the control group.

RESULT, DISCUSSION, AND SUGGESTIONS

The data collected through the test aimed to measure the improvement of the students' learning outcomes by implementing pre-test and post-test. It was found that the learning process that applied scientific approach by using the e-module based on learning cycle 7E can improve the students' learning outcomes in senior high schools. This is reflected by the mean difference between the increase of the pre-test and post-test scores of 57.96 in the experimental group and 52.41 in the control group.

On the other hand, the results of the t-test performed by independent Sample t-test also showed the same conclusion by looking at the significance value of the N-Gain data by 0.000 less than 0.05. Therefore, there is a significant difference in the pre-test and post-test between the experimental and the control groups. This proves that the learning process of the experimental group supported by the application of scientific approach using the e-module based on learning cycle 7E has increased the students' learning outcomes more than the learning process of the control group applying conventional method that is more dominated by lecturing. The data before the test has been through the prerequisite analysis test which results show that the data is normally distributed with the significance value of the experimental group of 0.264> 0.05 and also the control group of 0.192> 0.05. The next prerequisite test was the homogeneity test which showed that the data of pre-test and post-test were homogeneous with the significance value of 0.133 and 0.585 > 0.05 respectively.

The different results shown in both experimental and control groups have proven that the use of e-module based on learning cycle 7E for the application of scientific approach is very effective in improving students' learning outcomes. This reinforces the previous research conducted by Lim & Spahat (2006) that the e-module is a combination of technology and teaching materials which can appeal students because there are multimedia elements (audio, video, and images) inside which can help to understand the materials so that this media can create more interesting learning.

The implementation of curriculum 2013 that seeks to develop students' skills in three aspects, knowledge, attitude, and skills, requires learning process which refers to the student-centred learning (Prihantoro, 2015). Therefore, the ongoing learning process should use scientific approach intended to help achieve effective learning through a series of five stages: observing, formulating problems, proposing or formulating hypotheses, collecting data with various techniques, analysing data, drawing conclusions, and communicating the concepts, laws, or principles found (Daryanto, 2014; Hosnan, 2014). Learning with scientific approach has the main goal of preparing students with the provisions to have competitiveness for global competition (Daryanto, 2014). The process of scientific learning with the implementation of 5M learning activities can produce productive, active, creative, innovative, and affective students through strengthening integrated attitudes, skills, and knowledge (Ghaliyah et al., 2015). Scientific-approach learning can be implemented through the implementation of learning cycle 7E model that has 7 stages of eliciting, engagement, exploration, explanation, elaboration, evaluation, and extending (Eisenkraft, 2003). Learning by using the learning cycle 7E model can assist students in developing their understanding of the material delivered through the coherent phases (Hanuscin & Lee, 2008).

The first stage is eliciting included in the observation stage in the scientific approach. In this stage, a teacher seeks to generate the initial understanding of the students through the delivery of images related to the material to be provided with the intent to know the extent of knowledge possessed by the students (Eisenkraft, 2003). Eliciting stage is done at the beginning before the subject matter is given to attract students' attention by creating fundamental questions that are able to stimulate their initial thinking so that the students can develop their competence to search the information solemnly on the questions asked (Balta & Sarac, 2016; Supasorn & Waengchin, 2014).

Students' curiosity can be raised during the second stage of engagement by displaying an event in the form of a video so that they have the urge to form a concept of what has been understood (Balta & Sarac, 2016). In order to create a sense of curiosity in the minds of the students, the teacher guides them to pass small discussion activities or reads over the views that are seen to generate the students' interests, passions, and motivations. Thus, the students' focus is in learning more about the material (Balta & Sarac, 2016; Eisenkraft, 2003; Hanuscin & Lee, 2008). This stage can develop students' creative thinking through the curiosity that arises over the raised questions (Supasorn & Waengchin, 2014).

Exploration is the third stage carried out by doing projects in groups to conduct data collection, exploration of information, result interpretation, and conclusion drawing their provisional findings (Eisenkraft, 2003; Nuhoğlu & Yalçın, 2006). Group activities give students the opportunity to develop honesty, carefulness, respectful attitude, and communication with others through thinking stimulation and hypothesis development of the information obtained (Nuhoğlu and Yalçın, 2006: 49; Supasorn dan Waengchin, 2014: 745). Students' opportunities for exploration provide effective results to improve their academic and conceptual achievement (Balta & Sarac, 2016). The fourth stage is explanation. Students are given the opportunity to express their findings and the teacher as the facilitator is responsible for guiding the students in building on correct concepts, laws, and theories (Balta & Sarac, 2016; Eisenkraft, 2003).

Elaboration is the fifth stage done by encouraging students to use the understanding of symbols, definitions, concepts, and skills on the issues related to examples of the learned material acquired in the previous stage (Balta & Sarac, 2016; Eisenkraft, 2003). Furthermore, in order to find out the students' understanding of the material, the teacher conducts the evaluation at the sixth stage by using formative evaluation. This stage is done by asking questions in the form of multiple-choices and essay quizzes (Balta & Sarac, 2016). At the evaluation stage, students can develop their honesty by answering the questions independently, their carefulness on the answers done, systematic thinking by analysing the problems, and courage to express their opinions (Supasorn & Waengchin, 2014).

The last stage in applying the learning cycle 7E model is extending (Eisenkraft, 2003). This stage is done by connecting the material that has been received by the students with other related things so as to broaden their understanding through the development of the abilities to think, seek, and find new concepts (Balta & Sarac, 2016; Eisenkraft, 2003). The implementation of learning cycle 7E model be able to connect and transfer the information so that the students can visualize the information they obtained by the formation of concepts based on the acquired understanding. Successive-sequence stages in the learning process are able to develop a deeper understanding of the students in every stage (Hanuscin & Lee, 2008).

The application of scientific approach using learning cycle 7E can be combined with the use of learning media i.e. e-module (electronic module). The utilization of technology used as the learning media provides convenience for the students in understanding the material so that the results obtained are more optimal (Khodabandelou & Samah, 2012; Mainka & Benzies, 2012). An e-module provides students with an appeal in understanding the material, as evidenced by the research done by (Park, Sung, & Cho, 2015) that reading materials in the form of an application provide a better reading experience as the interest in reading comprehension is enhanced. The use of the e-module can develop students' cognitive abilities because of individual teaching and the improvement of information technology skills (Pummawan, 2006). E-module learning media collaborated with learning cycle 7E model can facilitate teachers in order to apply the scientific approach in the learning process in accordance with current curriculum demands. A steady understanding of the students can give effect to the achievement of the results of the learning process to be more optimal because the student's ability on the activities undertaken in each stage increases. Thus, a steady understanding of students can improve learning outcomes.

Higher increase occurred in the experimental group because of the application of scientific approach by using e-module learning media based on learning cycle 7E. The results of this study are supported also by the previous research conducted by Ghaliyah, Bakri, and Siswoyo (2015) which shows that the application of e-module based on learning cycle 7E can improve students' learning outcomes. The use of electronic media in the form of modules is more interactive because the materials in the form of animation, audio, and video can be included so that the students are more interested in learning the material and managing the mastery of the material individually in accordance with their speed of learning (Putra, Wirawan, and Pradnyana, 2017: 41). The existence of media used to provide convenience to students in understanding the material so as to increase motivation to follow the learning process (Ghaliyah et al., 2015; Sari, Santoso, & Murtini, 2018).

Based on the results of the research and discussion, it can be concluded that the achievement of the learning objectives can be done by making the learning process interesting through the use of technology as the learning media. The use of electronic learning media combined with the learning model is one effective way in accordance with the implementation of curriculum 2013 which implements scientific approach in teaching-learning activities to achieve student-centred learning. One effective media for applying scientific approach is e-module based on learning cycle 7E. The results showed that it can improve the students' learning outcomes because α value (sig. 0,000 < *0.05*) or there was a significant difference to the change in the learning outcomes between the students who were given treatment (experimental group) and those who were not (control group). Thus, the learning process takes place effectively and creates a fun atmosphere so that the students understand the material received more optimally.

Based on the conclusions of this study, the teacher is advised to always make innovations in the learning process. Teachers can use other supporting media. Further research suggested that the sample used is more extended, not only at the district level but at the national level. In addition, further research can be done by applying other media more effectively in improving student learning outcomes.

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