The effectiveness of e-learning based on SETS to improve students’ critical thinking skills in optical instrument material

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Abstract. Learning method affects learning outcomes, to obtain an effective and interesting learning process require an innovative learning method that is easily understood by students, namely by using learning media. This research applied Edmodo media, which was expected to improve student learning outcomes in SMA Terpadu Wira Bhakti of Gorontalo. The main objective of this research was to measure the effectiveness of e-learning based innovative learning sets with Edmodo to improve students’ critical thinking skill in optical instruments material in SMA (Senior High School). The method used was Research and Development (R & D), with one group pretest-posttest design. The developed learning sets were syllabus, lesson plan, teaching material, Student Worksheet, Learning Outcomes Test, and assessment instrument. The research finding and analysis showed that the improvement in students’ critical thinking skills on social media was very high, where the average N-gain value was 0.72. Based on the previous finding, it could be concluded that e-learning-based innovative learning set with Edmodo was effective to improve students’ critical thinking skills in the material of the optical instrument.

1. Introduction
The development of technology and information has become one of the basic foundations in the development of 21st-century learning. Information technology seems to be a mandatory thing used in daily life, and one of them is internet use, where Indonesia records a significant yearly increase in internet usage. The Regulation of Minister of National Education No. 16 of 2007 states that one of the teacher's compulsory competencies is to use information technology in conducting educational learning activities. The 21st-century learning order and changes in the 2013 curriculum require teachers’ pedagogical skills as a teacher to be able to design learning to be more interesting and meaningful. Teaching and learning activities must be extended beyond the boundaries of a classroom, in addition, the interaction of students with surrounding environment must be augmented with various forms of learning design or in this case is learning set [1]. This is intended to answer the problem that appears due to the industrial revolution 4.0 in the world of education.

The industrial revolution 4.0 is an increasingly sophisticated world situation in various fields, particularly in the field of education. Thus, the world of education must be able to take a role and solve the existing problem. One thing that can be done by the world of education is to design learning sets in a certain way thus students can learn anywhere and anytime. The number of internet services makes the learning process easier to access. This change underlies education shift in the 21st century.
Learning is a system consisting of various components that are related to one another. These components include: 1) objectives; 2) material; 3) method; and 4) evaluation. The four components of learning must be considered by the teacher in choosing and determining what learning model to use in learning activities. As an educator, it must at least be responsive to the changes in education media. Internet-Assisted learning is better known as online learning by utilizing media in the form of e-learning. Online learning is learning that utilizes the internet network as support of the learning process. Meanwhile, the learning media used is in the form of e-learning media, namely computer network [1]. The present advancement of information technology causes a flow of information and knowledge to be obtained easily without obstacles in space and time. Various sources of knowledge are also no longer limited to a formal educational institution, or the learning process does not only occur in the classroom when face to face but also it can be done remotely by using the internet network. In this position, the teacher will function more as a mediator in the learning process [2].

The learning process that can be observed and measured scientifically commonly uses innovative learning model design to be able to evoke students’ critical thinking process in the certain subject material. The innovative learning models introduced by education experts are very diverse. The essence of this innovative learning model is to help teachers construct an understanding of students’ concepts towards learning material. In science learning concept, particularly physics, it is very suitable to apply constructivism learning theory. Constructivism is the understanding of learning theory that requires students to discover, build, and understand their own knowledge regarding the concept of learning through learning experience process [3].

Student learning achievement is strongly determined by the intellectual/ cognitive development. Human cognitive development is a psychological process which involves a process of acquiring, compiling and using the knowledge and mental activities such as thinking, considering, observing, remembering, analyzing, synthesizing, evaluating and solving problems that take place through interaction with the environment. Cognitive learners develop in line with the interaction between aspects of development in one with other aspects and between students with one another as well as students with their nature. Thus, students are able to increase the potential of cognitive intelligence, which is characterized by skills in thinking, one of which is able to think critically.

The initial survey conducted by researcher in September 2018 which involved 43 students and 10 physics teachers as respondents showed that: 1) there were only a few teachers that used laptops, gadget (android/ tab) as support in the learning process; 2) there were only a few teachers who applied e-learning learning process as support of learning, and 3) 70% of teachers agreed that e-learning-based learning was applied in the world of education. This meant that if the face to face learning process has not been completed, it can be done with distance learning by using e-learning-based media. Based on the earlier explanation, the researcher wanted to measure the effectiveness of e-learning based innovative learning sets with Edmodo to improve students’ critical thinking skills in the material of the optical instrument.

2. Methods
This research was Research and Development or abbreviated as R & D which focused on measuring the effectiveness of e-learning-based innovative learning sets with Edmodo that was effective for improving students’ critical thinking skills in optical instruments material. The method used in this research was pre-experimental with one group pre-test and post-test design. This design consisted of one group (no control group), while the research process was conducted in three stages, namely: (1) conducting pre-test to measure the initial condition of respondent before being given treatment (O₁), (2) giving treatment (X), and (3) doing post-test (O₂) to determine the condition of dependent variable after being given treatment [4]. The design of this research can be seen in Figure 1:
The population of this research was all students of class XI IPA 2 as many as 19 people at SMA Terpadu Wira Bhakti Gorontalo, Suwawa Sub-district, Bone Bolango District, Gorontalo Province. The research instrument used in this research was a test of students’ critical thinking learning outcomes. A research instrument is a tool used to measure a certain phenomenon that was observed [5]. The technique of data analysis in this research used descriptive analysis on the effectiveness of learning sets. Analysis of the effectiveness of learning sets is obtained based on (1) analysis of students’ activities in learning, and (2) analysis of students’ critical thinking learning outcome. In addition, the research used N-Gain (gain-normalized) analysis to find out to what extent to effect of the application of e-learning with Edmodo on the improvement of students learning outcomes analysis. The N-gain score is a score comparison of an actual mark with the maximum gain score. The actual gain score is the gain score obtained by students, while the maximum gain score is the probable highest gain score obtained by students. The following formula was used to calculate the value of N-Gain \( \langle g \rangle \):

\[
\langle g \rangle = \frac{\% (S_f) - \% (S_i)}{100 - \% (S_i)}
\]

As information, \( \langle g \rangle \) is the improvement of learning outcomes (normalized gain), \((S_f)\) is the final test value (post-test), and \((S_i)\) is the value of the initial test (pre-test) [6]. The obtained N-Gain value was interpreted by using Hake formula, and it can be seen in Table 1.

| No. | Value \( \langle g \rangle \) | Classification |
|-----|-----------------|----------------|
| 1   | \( \langle g \rangle > 0.7 \) | High           |
| 2   | \( 0.3 \leq \langle g \rangle \leq 0.7 \) | Small          |
| 3   | \( \langle g \rangle < 0.3 \) | Large          |

3. Result and Discussion

3.1. Result of Students’ Activity Observation

The result of students’ activity observation was obtained through observation sheet of student activities conducted by observers within each meeting. The observers assessed students implementation activities in each aspect of 5M activities, were: observing, asking, collecting data, associating, and communicating in each learning process. The results of the assessment by observers in 4 meetings of the learning process could be seen in Table 2.

| Average Percentage of Students’ Activity Per Aspect |
|-----------------------------------------------|
| Observing | Asking | Collecting Data | Associating | Communicating |
| 87.50%    | 83.33% | 87.50%          | 100%        | 100%          |

Table 2 shows the result of observations of students’ activities in observing aspect was 87.50% or meeting very good criteria, asking aspect was 83.33% or meeting good criteria, collecting data aspect...
was 87.50% or meeting very good criteria, associating aspect was 100% or meeting very good criteria, and communicating aspect was 100% or meeting very good criteria. The criteria of students’ activities assessment were done by matching results of average total score as obtained [7]. The result of observation and assessment was performed by observers towards students’ activities that the application of e-learning-based learning assisted by edmodo could improve students’ activity in the learning. In addition, it was seen from aspects of observing, collecting data, associating, and communicating, which met very good criteria and good criteria for asking aspect. The presence of e-learning-based could make students truly to be active and having the high self-regulated (self-regulation/ independent) ability in learning, and the students wanted to find out what was not being understood. The ability of self-regulated learning in learning could be trained through a variety of developed scaffolding to improve students’ activity in learning [8]. This was in line with Oemar Hammalik, who said that the application of e-learning could make students become the central point of teaching-learning activities due to they always referred to independent learning for personal self-development [1]. The same thing also said that through e-learning, students could become active, centered on students themselves, and train to be more independent in gaining knowledge [2]. The result of previous research also showed that the presence of e-learning assisted by edmodo could improve the percentage of students’ activities in each cycle for 69.4%, 75.0%, and 83.0% [9].

3.2 Result of Critical Thinking Learning Test

Analysis of students’ learning outcomes was the main instrument in testing the effectiveness of certain sets that were developed. The learning outcomes test was given after treatment (post-test) and was intended to identify the improvement of learning outcomes for success and effectiveness of the set. The set is said to be effective if it experiences improvement in previous learning outcomes tests [5]. Test on the result of students’ critical thinking learning in this research was obtained through an essay test containing 10 questions given to 19 students after going through 4 meetings in the learning process. The first, the researcher conducted pre-test, which aimed to find out the students’ critical thinking skills before conducting learning activities. Then, after the researcher conducted 4 meetings of the learning process, the researcher conducted post-test as an evaluation of the learning process. The average results of pre-test, post-test, and normalized gain (N-Gain) were presented in Table 3.

| Table 3. Students’ Learning Outcomes |
|--------------------------------------|
| **Value Average** | **<g>** | **Criteria** |
| **Pretest** | **Posttest** | | |
| 32.50 | 81.33 | 0.72 | High |

Table 3 showed the result of students’ critical thinking learning. The number of students who obtained KKM or minimum completeness criteria score above 75 was 15 students and meeting completed criteria, while 4 students obtained KKM score less than 75 so that they were categorized in incomplete criteria. The average result of pre-test before being given treatment was 32.50% and after treatment improved for 48.83% to be 81.33%. The percentage of classical completeness in critical thinking was 78.95% or in good category. The improvement of students’ learning outcome towards the effect of the use of edmodo in the cognitive domain by using N-Gain (g) analysis met very high criteria as the overall average value was 0.72. The results of the research indicated that students’ learning outcome improved when using e-learning-based learning assisted by Edmodo. This was in accordance with previous research which stated that the application of edmodo could be proven by the percentage of students’ learning completeness namely from pre-cycle to cycle 1 improved for 31%, from 1 to cycle 2 improved for 62%, and from pre-cycle to cycle 2 improved for 93% [10]. Similar research also showed that the product was effectively verified in learning, with a percentage of 88.82% [11]. The previous research also showed that the effectiveness of using e-learning media with edmodo was higher than using conventional learning media in improving students’ learning outcomes.
with a normalized gain value of 0.8 or in very high criteria [12]. In addition, the other also showed that learning outcomes after using learning media with edmodo based e-learning found students’ cognitive value that was quite improved to 76.05% compared to the previous one [13]. The clearer information could be seen in Figure 2, which showed the average result of students’ critical thinking learning.

4. Conclusion

Based on the result of research and discussion towards the result of data analysis, it could be concluded that e-learning-based innovative learning sets assisted by edmodo was effective to improve students’ critical thinking skill in optical instruments material at SMA Terpadu Wira Bhakti of Gorontalo at Class XI IPA 2, so that it becomes one of the alternatives as learning model.

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