Designing e-learning based independent learning activity unit through virtual worksheet: improving student’s 4Cs

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Abstract. The subject of Physics at Sumenep Senior High School grounded in 4C’s (Communication, Collaboration, Critical Thinking, Creativity) has not yet been deliberately developed because of the lack of learning tools oriented in the 4C’s. Independent Learning Activity Unit (UKBM) as teaching systems that develop 4C’s can be used to enable students to solve problems. In this research was to create e-Learning Independent Learning Activity Unit teaching are developed through Virtual Worksheet which can improve the student 4C’s. The development of teaching tools was conducted in five major steps (Analysis, Design, Development, Implementation, Evaluation). The characteristics of the UKBM e-Learning are developed through problems on a virtual worksheet, which must be solved by students. This study material is centered around students and must be completed individually and in groups. The results showed that teaching systems were valid. The effectiveness of teaching systems based on concept understanding was increased by an average N-gain of experimental class which are respectively classified as high category. The feasibility of the teaching systems on the treated (experiment) class from the first until the seventh meeting was in a good category. The teacher and students responded positively to the teaching systems in the classroom.

1. Introduction

There are higher schools in Sumenep regency which are using 2013 curriculum by doing a Semester Credit System (SKS: Sistem Kredit Semester). Based on the result of document study that is determined by information in Physics. The students use text books but not all students own a copy because the teacher does not require them to do for this study program. The teacher asks the students to use a laptop or smartphone during at the class to search for information about the material. In the Physics study course, the teacher gives the students handouts to practice the Physics exercise. Based on the questioner given to the twelfth-grade science students, 75% say that physics is difficult material to understand, and about 60% of the students say that they do not have a physics text book.

Based on the explanation above, a system of Learning Independent Activities (UKBM, Unit Kegiatan Belajar Mandiri) was developed based on virtual worksheet-based e-learning and was a breakthrough in developing teaching materials into an interactive and easier learning media used by students. The development of UKBM e-learning based on virtual worksheets is an electronic worksheet created by using software that basically converts paper worksheets into digital files that allow the students to interact with worksheets on computers [1]. These files are generally created by scanning paper documents or worksheets into the selected program and then saving them as images (jpg, gif, bmp, or tif) or in the scanned program format [2].
Semester Credit System learning must be equipped with the skills needed in the 21st century. Developing technology requires having the 4C's skills [3]. The 4C's skills applied in learning can improve efficiency in problem solving [4]. Communication is not just the ability of conversation. The meaning of communication has changed in line with increasing the development of technological changes. Communication is a skill needed in the 21st century. Based on the changes in communication patterns such technology holds full control in the lives of individuals. Even though individuals should control technology. Students are more active in social media than interacting face-to-face. Such behavior causes students to be less sensitive, not to care about their surroundings, and the higher the attitude of individuality. These things cause the students have poor communication skills. Therefore, communication skills are currently developed using technology tools or media [5]. Collaboration is also one of the skills needed in the 21st century. Learning that emphasizes collaboration skills makes students able to establish good cooperation and be able to solve problems well [6]. The ability to solve problems is closely related to students' thinking processes. One of the thinking skills is critical thinking.

Critical thinking is a process that facilitates students to gain new knowledge through problem solving and collaboration [7]. Critical thinking focuses on the learning process rather than reaching information alone [8]. These skills involve finding out how to research, unite, make decisions, create and apply new knowledge to real-world situations that cause students to experience optimal development [9]. The optimal development of students' creative skills in the learning environment is closely related to the way the teacher teaches [10]. Becoming creative students, the teacher must have the ability to use the latest technology as a learning [2].

2. Method
The development of UKBM e-learning system based on virtual worksheets in this study is a process used to produce learning devices. The development of the learning device uses the ADDIE system development model.

The validity of the learning device developed was seen based on content validity. The content validity determined by expert judgment obtains a valid average score category. The effectiveness of learning devices is seen from the results of one-way analysis of variance from the value of the pre-test and post-test. The gain index with medium to high criteria is an indicator of the success of the device being developed. The practicality of the UKBM e-learning model is the implementation of learning using the tools developed, as well as positive responses from teachers and students who become respondents. The product is declared practical if 75% or more respondents give a positive response to the product being developed.

3. Results and Discussion
UKBM e-learning based on virtual worksheets is centered on students learning independently. Learning leads students to investigate and prioritize the responsibility and independence of students by finding supporting information from various sources. Students gather supporting information through individual and group activities through reading and online library studies. When having discussions in groups and class, students are given the opportunity to exchange ideas or opinions with other students.

UKBM e-learning is based on virtual worksheets that are validated in the form of syllabus, lesson plan, UKBM, evaluation instruments, teacher response questionnaires, student questionnaire responses, and learning implementation observation sheets. The results of the learning device validation can be used with a slight revision, so that revisions are made before the learning device is tested. The validator assessment states that the validity of the learning device obtains a valid average score for all the learning devices developed.

The gain index from the pre-test and post-test values is an indicator of effectiveness. The pre-test was conducted before learning activities in the experimental and control groups. At the end of the learning activity a post-test was given. The results of the pre-test values of the experimental and control classes are presented in Table 1.
Table 1. Results of Analysis of Pre-Test Values and Post-Tests

| Class  | Average Pre-test | Average Post-Test | Average N-gain | Criteria |
|--------|------------------|-------------------|----------------|----------|
| Experiment | 42.91             | 85.34             | 0.74           | High     |
| Control   | 43.55             | 80.96             | 0.68           | Middle   |

The pre-test results between the experimental and control classes were then tested for a difference of two averages. The results of the test analysis of the two average differences between the experiment and control classes found that there was no significant difference between the experiment and control classes, so it can be concluded that the experiment class was no better than the control class.

The learning process of the experimental class uses UKBM e-learning based on virtual worksheet while the control class uses lecture and discussion methods. At the end of the learning process a post-test was conducted to determine the students' ability to understand the concepts in the two classes. The post-test data obtained was then analyzed by the normality test, the similarity test of two variances, and the test of the difference in the two averages. The results of the post-test data normality test are displayed in Table 2.

Table 2. Results of Normality Test for Post Test Data

| Class  | Average | Dk | $\chi^2_{test}$ | $\chi^2_{table}$ | Criteria |
|--------|---------|----|----------------|------------------|----------|
| Experiment | 85.34   | 5  | 9.8007         | 11.070           | Normal   |
| Control   | 80.96   | 5  | 4.4910         | 11.070           | Normal   |

Based on Table 2, it is obtained that the data from the post-test experimental class and control class are normally distributed. The results of the two-variance similarity test post-test data of the experimental group and the control class are shown in Table 3.

Table 3. Homogeneity Test Experiments and Control Classes

| Class  | Average | Dk | $F_{test}$ | $F_{table}$ | Criteria |
|--------|---------|----|------------|-------------|----------|
| Experiment | 85.34   | 124 | 1.015      | 1.39        | Homogeneous |
| Control   | 80.96   | 124 | 1.015      | 1.39        | Homogeneous |

The gain index in the experimental class is higher than the control class, this shows the effectiveness of UKBM e-learning based on effective virtual worksheets. UKBM e-learning based on virtual worksheets is effective because it provides opportunities for students to learn more independently, exchange ideas with each other and help each other to solve every problem given by the teacher. Improved understanding of concepts occurs in this study because UKBM e-learning is based on virtual worksheets and active learning that is student-centered. In this study, the teacher acts as a facilitator not as source information, so students build new concepts actively through the problems that must be solved.

UKBM e-learning based on virtual worksheet requires students to be able to identify concepts, explore concepts, and then determine what will be done to obtain information. Active learning provides opportunities for students to construct their own knowledge. This is in line with the view that the teacher helps students in constructing their knowledge by making information very meaningful and relevant for students by giving students the opportunity to find and establish their own ideas for learning.

Understanding of concepts is the part of a person's thought processes that can be expressed with cognitive abilities (cognitive learning outcomes). Understanding of concepts is a set of mental processes that cannot be separated from students' thinking skills [11]. The practicality of learning
devices developed in this study obtained results of the implementation of learning, and the responses of teachers and students. These results form the basis for determining the practicality of e-learning based on virtual worksheets.

The results of observers’ observations during real teaching activities showed that scores from the implementation of learning at each meeting had a good category, meaning that UKBM e-learning is based on virtual worksheets developed practically based on empirical tests. In theory, the practicality of learning devices is acceptable because the implementation of UKBM e-learning based on virtual worksheets as the implementation of the device is carried out in accordance with the plan. The smoothness and suitability of planning with the implementation of learning, one of the factors is the practicality of the learning tools used in this study (Table 4).

### Table 4. Results of Implementation of Learning Observations

| Meeting | Number of Components | Score Number | Percentage (%) | Average Percentage |
|---------|----------------------|--------------|----------------|--------------------|
|         |                      | 1 | 2 | 1 | 2 | 1 | 2 |                  |
| First   | 24                   | 24 |79 |77 |66 |64 |65 |                  |
| Second  | 25                   | 26 |83 |85 |75 |77 |76 |                  |
| Third   | 25                   | 26 |83 |85 |75 |77 |76 |                  |
| Fourth  | 28                   | 29 |90 |92 |79 |80 |79.5 |                  |
| Fifth   | 30                   | 30 |95 |97 |80 |81 |80.5 |                  |

Overall on the implementation of the UKBM learning process based on virtual worksheets, the activities at each stage of learning were carried out by the teacher well in accordance with the UKBM e-learning model.

Based on the observations of students and teachers who have used UKBM e-learning based on virtual worksheets, it was found that UKBM virtual worksheet-based e-learning can be used well and fills a very important role in fostering an interactive and communicative learning process. It can be seen from the activities of students during the learning process, where students are very enthusiastic and have high enthusiasm in solving the problems given. During activities that take place in groups, students build their learning experiences based on prior knowledge or experience [10, 12, 13].

Such learning helps the teaching and learning process run well and help participative students build on their own knowledge. In addition, teachers are required to create and guide students to express their ideas and concepts, so that the concepts learned will be retained and can improve student learning achievement [14,15,16]. The characteristics of a constructive learner are that knowledge is built on prior experience or knowledge, so learning is an active process where learners learn based on experience and knowledge that grows and develops from the learning process and occurs through constructive thinking [17].

### 4. Conclusion

UKBM e-learning is based on a virtual worksheet of the static electricity’s subject matter in the form of: Syllabus, Lesson Plans, UKBM e-Learning, and Evaluation instruments that have met valid criteria. This can be seen from the validity of learning devices in research reaching more than 3.25. UKBM e-learning based the virtual worksheet on the subject of static electricity using effective developed devices. The effectiveness seen from the analysis of the gain index average understanding of the experimental class concept is higher than the control class. UKBM e-learning is a virtual based worksheet on static electricity subject matter using practical developed devices. The freedom of learning devices can be seen from the good learning achievement score categories (already more than the specified practicality criteria of 75%) and received a positive response from teachers and students. Student responses reached an average of 92.60% had a positive response. Teacher responses to learning devices achieve an average score of 93%. The results of the study are expected to provide a small contribution to thought as an effort to improve capabilities in the field of education and
especially in the field of physics. Suggestions that can be composed of contributors in connection with the results of this study are as follows. Learning using UKBM e-learning based virtual worksheet which is static electricity subject matter students can be used as an alternative that can be chosen by teachers in learning Physics on static electricity material. The teacher can use the UKBM e-learning based virtual worksheet of static electricity subject matter to increase the 4C’s.

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