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Online-Based Applied Physics Learning

Effectiveness of Interactive Digital Teaching Materials

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***Abstract*—The aim of the study was to describe the effectiveness of online-based applied physics learning using interactive digital teaching materials. This type of research is quasi-experiment using time-series design. Effectiveness seen of four dimensions of knowledge and student response, Learning is a manipulation variable and knowledge is a dependent variable. The research subjects were 40 students of the Physics Department at Universitas Negeri Surabaya. Five topics Physics are discussed periodically. Assessment of 4 dimensions of student knowledge and response using a Likert scale of 1-5. Data analysis using descriptive statistics, effective learning if the average value of mastery of each dimension of knowledge ≥ 3.1 (scale 0-5) on each topic of discussion with a fixed or rising trend. Based on student responses effective if the percentage obtained 61%. The results are: 1) the average score of the dimensions of student knowledge ≥ 3.1 namely factual knowledge (4.28-4.45), conceptual knowledge (4.23-4.41), procedural knowledge (4.02-4.31), and metacognitive knowledge (3.73-4.01); 2) Effectiveness based on student responses ≥ 61%, each aspect gets a score with a range (85.6-94.4). The result shows that online-based learning of Applied Physics using interactive digital teaching materials can produce four dimensions of knowledge and get a positive response.**

Keywords—online, learning, digital, teaching materials

I. INTRODUCTION

The current learning trend is teacher-centered teaching into a more student-centered approach. The opportunities to explore questions, develop and test hypotheses, so that they can provide more opportunities for students to reflect on their own learning, get a deeper understanding of these concepts. Integrated way and become better critical thinkers. Many countries define science teaching as having characteristics [1], which is where science teachers avoid memorization and only convey small facts from science. Physics is part of science that studies natural phenomena or phenomena related to matter and energy, which play an important role in the development of technological progress and the concept of life in harmony and balance with nature. The provision of Physics teaching materials in the learning process must be integrated in accordance with the meaning of the nature of Physics and can accommodate students' thinking skills to a higher level. Higher-order thinking skills are fundamental changes in educational assessment that aim to introduce students' thinking skills and learning experiences or more than repeating information or facts. [2]. At present the application of education with online learning has begun to develop. Students not only can access knowledge from text books but can also access learning from outside the school. Teachers and students can get a lot of information, unlimited, and can be accessed from several libraries around the world. The internet has the ability to provide information with a variety of media (including print, video and voice and music recordings) so that the internet becomes an unlimited library. Students and teachers can improve learning in the classroom by accessing information from various sources on the internet through websites or other education service providers. These developments are used by a number of educational institutions to conduct online learning by holding schools or online courses. Even among universities, the Ministry of Research, Technology and Higher Education has made guidelines for the implementation of online lectures [3].

One professional teacher competence is that the person concerned must have the ability to develop learning that can utilize information and communication technology. In addition, the current trend is to develop learning that reduces the use of paper in schools, so the use of computers in learning becomes a necessity in schools, both for the benefits of the learning process (e-books, media, learning resources, etc.) and evaluating results learning (online exam and offline exam). One thing that needs to be considered in online learning is the preparation of teaching materials that are not only digital, but the packaging must be more interesting than paper-based ones. This potential is very large in the use of digital teaching materials, because it allows teachers to integrate multimedia (text, images, sound, and animation) into interactive digital teaching materials.

Applied Physics studies is used in everyday life. Concepts, theories, and laws of physics are often found in everyday life, but they do not consider it as an activity that is applied from generation to generation. The best way to teach Applied Physics is providing opportunities for students to analyze and evaluate a symptom in everyday life that contains Physics concepts and principles, and create ideas based on their analysis and evaluation. This course is in need of learning media that can provide a real picture of how various facts, concepts, theories, and principles of physics are used in everyday life. Applied Physics Learning in the classroom, experiences, experiences, problems, real-life events apply to the concepts, theories and principles of physics because of the limitations that exist. The use of multimedia is an alternative means of effective in overcoming these obstacles. The use of

multimedia can also be integrated into digital interactive teaching materials to support online learning with more attractive packaging. Therefore, the aim of the research is to describe the effectiveness of interactive digital teaching materials in online-based applied physics learning.

The use of e-books has the potential to encourage students to read and understand them interactively and make them more comfortable, even though printed books have pictures, narratives, and graphics but e-books can be equipped with various features such as audio, music, animation, and video [4]. With these features it is possible to use e-books to train science process skills, namely the skills needed in scientific inquiry by students when learning science through cognitive processes, psychomotor, and affective [5]. The printed book contains a description of the material about a particular subject or field of study, systematically and selected based on a specific purpose arrangement, and used to help students learn or learn activities in school [6]. The existing development of computers for its operations, and more on students' cognitive abilities and does not integrate virtual laboratories related to the material inside, so students cannot experiment [7]. The main advantage when using online-based learning is that it can reduce paper usage [8] and can be more communicative. The use of video can be directed to train some elements of science process skills such as observing, classifying, inviting, predicting, and communicating. Besides that it can also be used to develop several elements in critical thinking skills such as analyzing, evaluating, applying, generating ideas, and expressing ideas.

Applied Physics Learning requires a scientific approach to train science process skills and critical thinking skills. Therefore, videos and gif images are added to the e-book, but can also be used to train science process skills and critical thinking skills. Interactive Digital Teaching Materials developed are teaching materials that are equipped with various features that can train science process skills and critical thinking skills. The development of teaching materials is focused on science process skills and critical thinking skills, so that through these teaching materials students are given the opportunity to study the symptoms and applied physics in daily life.

Interactive digital teaching materials for learning Applied Physics developed in the study focus on trainers to master the four dimensions of knowledge that include factual, conceptual, procedural and cognitive so that they can be developed optimally. Maximally in online-based Applied Physics learning, researchers believe that students' Applied Physics learning outcomes will be better.

II. Research Methods

This type of research is quasi-experiment with time-series design, which measures the dependent variable in a group before and after treatment in order to determine the impact of the treatment with repeated measurements at a certain time period. [9]. Manipulation variables in this study are online-based learning using interactive digital teaching materials, while the dependent variable is mastery of applied physics in terms of four dimensions of knowledge (factual, conceptual, procedural, and metacognitive) whose measurements are based on: clarity, breadth, depth, accuracy, precision. The definitions given for the four dimensions of knowledge are: 1) Factual are the basic elements that must be known when solving problems in the symbols combined in several real references or a series of symbols that carry important information; 2) Conceptual is the category and classification as well as the relationship structure that presents how special the material is structured and structured more systematically; 3) Procedural is the process of how to do something, known as procedure or sequence of steps; 4) Metacognitive is the ability to control the cognitive domain or aspect. Which controls six levels of cognitive aspects that cover the stages, understanding, application, analysis, synthesis, and evaluation. In this study, repeated measurement was only done after treatment because it was used a performance test.

The procedure in this study is to apply online-based application learning using interactive digital teaching materials, which include web guides, handouts, video phenomena, and assignments. Mastery of Applied Physics is measured through performance appraisal of tasks given by the mastery of four dimensions of knowledge from students. Students were then given a questionnaire to get their response to the learning process. A web guide is a web that contains a summary of the material, a reference book link, a video phenomenon link, and a task guide for students to do. Handout is a sheet that contains a description of the material according to the topic discussed. The video of the phenomenon is a series of events related to the topic discussed. The task is a series of steps that must be done by students to master the Applied Physics according to the topics discussed based on four dimensions of knowledge. The five topics discussed in learning are: Motion, Newton's Law, Style and its application, Work and Energy, Momentum and Impulse. The research subjects were 40 students of the Department of Physics at Surabaya State University.

Data collection techniques use performance tests and questionnaires. The score of mastery of applied physics is obtained from the assessment of student answers using a Likert scale (very less = 1, less = 2, enough = 3, good = 4, and very good = 5). Likert scale with the same criteria was used to questionnaire student responses to the learning process.

Data analysis using quantitative descriptive. The description of effectiveness is obtained based on the average score of student mastery on each dimension of knowledge, and the student's response to the learning process. Learning is declared effective if the average value of each dimension of student knowledge ≥ 3.1 (scale 0-5) in each topic of discussion with a fixed or rising trend. Effectiveness in terms of student responses is obtained by summing all the average scores given by students divided by maximum scores multiplied by 100%, effective learning if the percentage obtained is $\geq 61\%$.

III. Result and Discussion

A. Mastery of factual knowledge

Score of factual knowledge mastery from online-based Applied Physics learning using interactive digital teaching materials for five topics with consecutive time periods as shown in Figure 1.

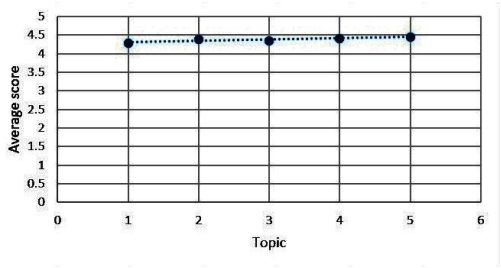

Fig. 1. Average score of factual knowledge

Figure 1 shows that for conceptual knowledge, students have an average score of ≥ 3.1 with a score range (4.28–4.45). So that learning effectively provide factual knowledge to students.

B. *Mastery of conceptual knowledge*

Score of conceptual knowledge mastery from online-based Applied Physics learning using interactive digital teaching materials for topics with consecutive time periods as shown in Figure 2.

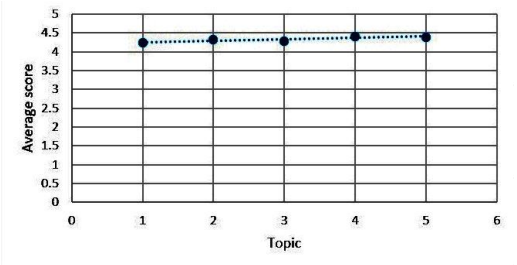

Fig. 2. Average score of conseptual knowledge

Figure 2 shows that for conceptual knowledge, students have an average score of ≥ 3.1 with a score range (4.23–4.41). So that learning effectively provides conceptual knowledge to students.

C. *Mastery of procedural knowledge*

Scores of procedural knowledge mastery from online-based Applied Physics learning using interactive digital teaching materials for five topics with consecutive time periods as shown in Figure 3.

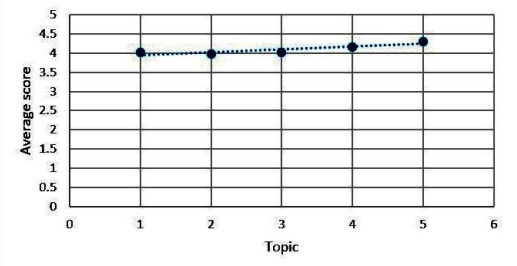

Fig. 3. Average score of procedural knowledge

Figure 3 shows that for procedural knowledge, students have an average score of ≥ 3.1 with a score range (4.02–4.31). So that learning effectively provides procedural knowledge to students.

D. *Mastery of metacognitive knowledge*

Scores of metacognitive knowledge mastery from online-based Applied Physics learning using interactive digital teaching materials for five topics with consecutive time periods as shown in Figure.

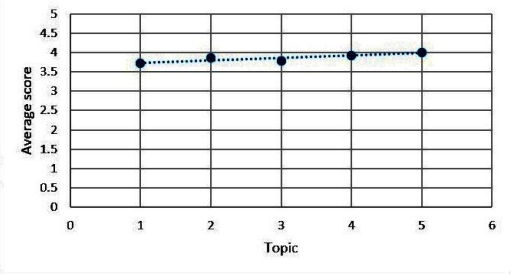

Fig. 4. Average score of metacognitive knowledge

Figure 4 shows that for metacognitive knowledge, students have an average score of ≥ 3.1 with a score range (3.73-4.01). So that learning effectively provides metacognitive knowledge to students.

E. *Student response to the learning process*

Student responses to online-based Applied Physics learning using interactive digital teaching materials can be presented as shown in Figure 5.

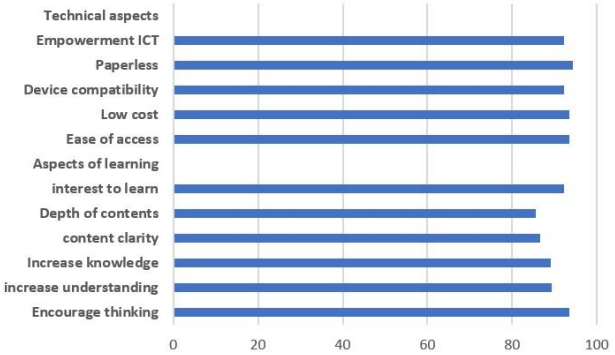

Fig 5. Effectiveness based on student responses

Figure 5 shows that the effectiveness of learning based on student responses ≥ 61% with a score range (85.6-94.4). So online-based Applied Physics learning using digital interactive teaching materials is effective based on student responses.

F. *The effectiveness of the learning process*

Online-based Applied Physics learning uses digital interactive teaching materials carried out through learning websites. The website serves as a guide that has a main page and several sections that contain general guidelines and specific guidelines for each topic of Applied Physics. The

tools needed to provide students with four dimensions of knowledge (factual, conceptual, procedural and cognitive) are available on the website by providing guides, handouts, videos of phenomena and tasks that can be accessed through the links provided. Conceptually the learning created can website is used to train thinking to obtain the four dimensions of knowledge. To manage human resources in learning, important factors that must be considered include environmental, information and communication systems [10]. Logical argument shows that there is a natural fit between knowledge management and e-learning, which together express ways of professional development in knowledge-based societies [11]. There is a video that displays a phenomenon of physics that allows students to make observations, so opportunities for students to proceed to explore the factual, conceptual and metacognitive knowledge. The ability of students to master is presented in figure 1-4. Knowledge management needs to pay attention to how to choose knowledge, store knowledge and apply knowledge [12]. The features available on this website allow learning scenarios, learning materials, learning media, and learning environments to be well developed.

Online-based Applied Physics learning using interactive digital teaching materials produces four dimensions of excellent knowledge for students. All knowledge dimension scores of students in successive periods indicating continuity and event tend to increase even though small. Each specific topic assignment is discussed together in class before they make a report. So they can share information to obtain four dimensions of knowledge optimally. Knowledge sharing is needed in managing classroom management [13]. Quantitative evaluation of tasks allows quantification of an increase in individual knowledge. Furthermore, a detailed analysis of relevant to individual tasks is useful for analyzing the results of assignments [14]. The results of previous studies found that online learning can train students' science process skills [15] and [16]. Other research found that learning with e-learning can improve learning outcomes in physics [17].

Student responses to online-based Applied Physics learning are very good as presented in Figure 5. All components asked to students which are divided into technical aspects and aspects of learning, all get good responses from students. Overall the percentage of effectiveness based on student responses ≥ 61%. Students' responses are also caused because the online learning process can be more flexible which can be done at anytime, anywhere, and under any conditions [18].

IV. CONCLUSION

The data obtained from the study produced: 1) the average score of the dimensions of student knowledge ≥ 3.1 namely factual knowledge (4.28-4.45), conceptual knowledge (4.23-4.41), procedural knowledge (4.02-4.31), and metacognitive knowledge (3.73-4.01); 2) Effectiveness based on student responses ≥ 61%, each aspect gets a score with a range (85.6-94.4). Based on the results obtained, it can be concluded that online-based learning of Applied Physics using interactive digital teaching materials can produce four dimensions of knowledge and get a positive response.

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