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IOP Conf. Series: Journal of Physics: Conf. Series **1022** (2018) 012025 doi:10.1088/1742-6596/1022/1/012025

Designing electronic module based on learning content development system in fostering students' multi representation skills

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Abstract. This study aims to develop electronic module design based on Learning Content Development System (LCDS) to foster students' multi representation skills in physics subject material. This study uses research and development method to the product design. This study involves 90 students and 6 physics teachers who were randomly chosen from 3 different Senior High Schools in Lampung Province. The data were collected by using questionnaires and analyzed by using quantitative descriptive method. Based on the data, 95% of the students only use one form of representation in solving physics problems. Representation which is tend to be used by students is symbolic representation. Students are considered to understand the concept of physics if they are able to change from one form to the other forms of representation. Product design of LCDS-based electronic module presents text, image, symbolic, video, and animation representation.

Key words: electronic module, learning content development system, multi representation

1. Introduction

Facing the rapid development of the 21st century era, educators and educational institutions are required to deliver students who have 21st century competence. Based on [1], there are ten types of 21st century competence, some of them are critical thinking, problem solving skill, decision making skill, effective communication skill, multi representation skills, information literacy, and ICT (Information and Communication Technology) literacy. In order to develop students' information literacy and ICT literacy competence, ICT integration in the learning process is needed. ICT integration, including internet, as a learning tool can support the increasing of students' information literacy and ICT literacy competence effectively [2]. Currently, ICT has been widely applied in the learning process. Many learning media are made by utilizing information and communication technologies such as computers. Even laboratory practice activities can now be done by utilizing ICT. Information and communication technology certainly has a large effect to overcome the limitations in the learning media.

Students' difficulties in understanding the lessons are influenced by some factors: (1) students only rely on one supporting book and it is the student worksheet. It shows that in terms of learning material,

it is still very limited, (2) there are still only few supporting media for the learning process such as internet, computers, and other media, and (3) because of the limited media, students are rarely invited to practice directly. These three factors have caused the students' low interest and motivation in the learning process. Research findings in the recent years provide a strong evidence on the importance of learners' control in the learning process that they undergo [3]. It is because the quality of education has relevance with the quality of the graduates, while the quality of the graduates is determined by learning process. While for educational institutions, students' high achievement indicates the success of the institutions in the learning process. As a professional teacher, the making of learning media becomes relatively easier when the development of this technology is optimally developed and implemented in the classroom learning process. Teachers can integrate educational technologies which enable the efficiency of the academic learning [4].

Based on an observation on physics learning process in high school, it is discovered that many factors influence the learning process, one of them is the students themselves. Students have different learning styles that influence the absorption of information. Based on data, it shows that 80% of the students claimed that it is difficult to understand physics material. There are 50% of the students who claimed that they quickly get bored when they study physics because the media that are used in the learning process are monotonous and uninteresting. This is in contrast to the results of interviews with high school physics teachers who claimed that their students are enthusiastic when they study physics, only a few students who look unenthusiastic. Teachers also claimed that students are able to follow the learning process and able to answer questions well in the question and answer session. Whereas in fact, many students still have difficulty in understanding physics material, this may be because of the deficiency in the variety of the media that are used in learning process. 95% of students claimed that in physics subject, especially the images and the formulas in the optical geometry chapter are still difficult to be translated into verbal definitions. Furthermore, students only use one type of representation to solve physics problems.

Skilled students tend to use non-mathematical representation, while less skilled students tend to directly use mathematical representation [5]. Students' success in solving physical problems is influenced by the representation format of the problems. Students also claimed that there is a significant effect on the learning approach that is used on their representational skill [6]. During this time, physics teaching process tends to use mathematical approach. Teachers spend too much time on math problems. Mathematical approach is conducted by giving examples and practice questions. Samples of questions are given in the classroom, the samples are either gotten from the textbooks or done on the board directly. For the further practice, homework is given to the students. Questions for the homework are usually in form of essays of three to five questions and they are taken from the textbooks [7].

Associated to multi representations, using multiple representation to support complementary processes rests on the now extremely well known observation that even representations that are informationally equivalent still differ in their computational properties [8]. Representation is something that has, describes, or symbolizes an object or a process. Multi representation means re-representing same concepts with different formats including verbal, picture, graphic and mathematic [9]. Multiple representational formats in a particular concept learning process give an opportunity to communicate it well, as well as how they work with systems and processes of a particular physical concept [10]. Multi representation in geometry proving learning process proposes three forms of representation; problem representation, visual representation, and evidence representation [11].

Multiple representations can be used so that one representation constrains interpretations of another one. Often learners can find a new form of representation complex and can misinterpret it. In this case one might use a second, more familiar or easy to interpret, representation to support learners' understanding of new complicated representation [12]. Each student has different specific ability from one another, some show that their verbal ability is more prominent, some show that their spatial and quantitative ability are stronger, and the rest show that their visual and graphic ability are more solid. Performance of various representations when a concept is explained will certainly give an opportunity

to the students to be able to understand the concept using their own specific abilities. This is in line with opinion [13], which states that multiple representations can support construction of a deeper conceptual understanding. Along with the development of computing technology field, representations of various physical quantity interaction in a phenomenon can be presented by using dynamic formats in form of animations and simulations [14].

One of the media that can present material in multi representation is module. Module is a set of learning media that is arranged systematically. It is a complete teaching unit designed to be used by a teacher or a small group of learners without the presence of instructor [15]. The purpose of this module is to facilitate the learning process without regular supervision, all elements of a course which are given by teachers normally should be formed into a set of printed, audiovisual, or computer-based materials (or any combination of them).

Although module can be used independently by students as learning media, it should be still combined with face to face learning activities with teacher. Learning method that combines between e-learning system with conventional or face to face method is called blended learning. Blended learning is a combination of various learning models aimed to optimize learning process either it is distance, traditional, media using, or even computer based learning process [16]. Students who are taught by using blended learning method have higher achievement than those who use traditional one [17]. Students who use blended learning method also have higher average score than those who use traditional learning methods [18].

One of the programs that can be used to construct interactive modules that can be used in blended learning process and to allow the development of multi representation skills is LCDS. Based-on [19], Microsoft Learning Content Development System (LCDS) is a free tool that enables Microsoft training and certification community to create high-quality, interactive, online courses and Microsoft Silverlight Learning Snacks. LCDS allows anyone in Microsoft training and certification community to publish e-learning courses and Learning Snacks by completing easy-to-use LCDS forms that seamlessly generate highly customized content, interactive activities, quizzes, games, assessments, animations, demos, and other multimedia. LCDS allows anyone in a specific community or organization to publish e-learning using LCDS easily with customizable content like interactive activities, quizzes, games, exams, animations, demos, and other multimedia [20]. LCDS helps to create content with text and pictures, interactive activities, quizzes, games, assessments, animations, demos, and other multimedia. It also provides the decision to embed pictures, movies, audio files, flash and silverlight content into the course. These features of LCDS and its support for teaching and learning gives a clear indication that would be appropriate to design and develop a suitable learning set for teaching and learning of electrical and electronic technology concepts [21].

Based on the description above, the researchers made an alternative way by designing an interactive learning media in form of electronic modules that can present a more attractive physics material by utilizing the development of information technology. The researchers conducted a development research aimed to produce a design of an interactive module based on Learning Content Development System (LCDS) to cultivate students' multi representation skills in Geometry Optical materials.

2. Method

This research can be classified as education development research, which is a development of LCDS-based electronic physics module especially in optical geometry material to foster multi representation skills. The product of this development research is an electronic module based on LCDS especially in optical geometry material to foster multi representation skills.

This research uses research and development method based on media development research design by Sugiyono [22]. Sugiyono's research design step consists of 10 steps: 1) potentials and problems, 2) information gathering, 3) product design, 4) design validation, 5) design improvements, 6) product trials, 7) product revisions, 8) usage trials, 9) design revisions, and 10) mass production. Sugiyono's research design step that is used in this study is limited only from the first to the third steps. Design

validation, product testing, until mass production are not implemented because of the researchers' limited time and fund.

Data collection techniques which are used by the researchers in this research is obtained through questionnaire, observation, and interview. Questionnaires, observations, and interviews are used to analyze students' initial needs at the needs analysis stage. Questionnaires were given to 90 students and 6 physics teachers in 3 different Senior High Schools in Lampung Province. Questionnaire data analysis technique was done by: 1) coding or classifying data; 2) performing data tabulation based on the classification made; 3) scoring the respondents' answers; 4) processing total score of the respondents' answers; 5) calculating questionnaire response percentage on each item; 6) calculating questionnaires' mean percentage; 7) visualizing the data; and 8) interpreting the score thoroughly.

3. Result and Discussion

The result of the development research that has been done is the LCDS-based electronic module to cultivate students' multi representation skills especially in geometric optical materials. This research is conducted through some steps based on development procedures that have been modified. The details of the results from each step are explained as follows:

3.1 Potentials and Problems

Based on the research which was conducted in 3 different Senior High Schools in Lampung Province, it is founded that methods which are used by teachers in the learning process is not attractive and monotonous, then it often makes students feel bored. 80% of the students claimed that it is difficult to understand physics materials, and 50% of the students claimed that they quickly get bored during the physics learning process because of the monotonous and uninteresting learning media. This is in contrast to the results of interviews with high school physics teachers who claimed that their students are enthusiastic during the physics learning process, only a few students who are not enthusiastic. Many students still have difficulty in understanding the physics material. It is because of the deficiency in the variety in the learning media . 95% of the students claimed that in physics subject, especially images and formulas in the optical geometry chapter are still difficult to be translated into verbal definitions. Furthermore, students only use one type of representation to solve physics problems, which is symbolic or mathematical representation.

3.2 Gathering Information

Based on the potentials and problems, information is collected until solution is gotten by developing an LCDS-based electronic module design to cultivate multi representation skills. The developed module presents material exposure with various representations, which are image, symbolic, and verbal.

3.3 Product Design

Initial product or module design is made by identifying module's material and format that are going to be produced . Product is developed by using LCDS program that is supported with other various softwares such as Macromedia Flash, iSpring quizMaker, and Wondershare Quiz Creator. The developed electronic module contains information that is presented with various representations such as light properties, light reflection, and light refraction.

The developed product is an interactive module with LCDS program. The said module is an interactive module to cultivate multi representation skills in Geometry Optical material. Before conveying the learning content, there is a cover page which was created by using introduction template with the module title, image associated with the material, author label, and the agency of the interactive module publisher label. After the cover, there is main page that is divided into three points, such as "User Guide", "Profile", and "Introduction". User manual submenu contains some buttons and its functions that are included in the interactive module. Content was made by using animation template. Then moving to profile submenu, it contains a short profile about the module author. This

section was created by using animation template. Next button is an introductory submenu that explains the purpose of creating the interactive module and also explains more about the material or contents of the developed module. This section was created by using introduction template.

After the main page menu, students then find a preliminary menu, which includes the core competence, basic competence, and indicators of learning competence achievement. All three submenus were created by using introduction template. After seeing the competence achievement indicators submenu, students directly enter the first learning material which is properties of light. The first material includes a brief explanation about properties of light. Properties of light menu is intended to remind students about the material they have learned at the intermediate school level. The five properties of light are presented by using introduction template as they consist of simple images and text.

After completing the first material, the light reflecting material is presented. The presentation of this material consists of prerequisite ability test, apperception, delivery of learning objectives, reflection law, and reflection on various types of mirror (flat mirror, concave mirror, and convex mirror). The prerequisite ability test submenu was created by using multiple choice template because it consists of five multiple choice questions about the material that has been studied, such as properties of light. Apperception and learning objectives for this material were created by using introduction template by displaying a simple image of rearview mirror. The next material is about regular reflection and reflective reflection that were created by using animation template because it consists of animations that describe the differences between regular reflection and reflective reflection.

Meanwhile, the reflection law material presentation begins with the presentation of a simple simulation by using the demonstration template. So, students can conclude the law of reflection . After understanding the law, students learn to apply the law on different types of mirrors. The first mirror is a flat mirror. This sub material presents the process of shadow forming on a flat mirror using a simple animation presented by using an animation template. In addition, on the next page, simple pictures and videos about the relationship between angle that is formed between two flat mirrors with the number of shadows that are formed provided in demonstration template. A formula is then given to calculate the number of shadows that are formed if two flat mirrors form a certain angle, along with the sample questions which are presented by using introduction template. The next submenu is presented by using animation template, in this experiment result submenu, a link to open a video about an experiment of two flat mirrors that form an angle is given. The video is used as a guidance for the module users to do the experiment, then input the observation data on animation which contains a set of questions that have been made by using QuisMaker iSpring software.

After that, the material is continued to the convex mirror material, which begins with convex mirror characteristic material which is consisted by a convex mirror and a concave mirror by using an animation in a demonstration template. After that, three special rays on the convex mirror are shown by using animation template. It is continued to a page that contains space numbering on convex mirror which is presented by using animation template. Still about convex mirror, the formation and characteristics of shadow on the convex mirror based on location of the object are displayed.

The presentation of this material is presented by using the animation template as well. Learning continues on the applied calculations on the convex mirrors material that presents the formulas and samples of problems in the convex mirrors shown by using animation template. The next submenu is Sample Problem submenu showing a sample problem about reflections on the convex mirror thoroughly. This submenu was created by using demonstration template. The last submenu on the light reflection material is comprehension test of the material presented in demonstration template as well. After completing the light reflection material, learning continues on refraction of light material. Learning begins with a prerequisite test about light reflection which consists of five items. This prerequisite ability test is presented by using Multiple Choice template. The second submenu is apperception of refraction.

Apperception is conveyed by using a picture of a spoon phenomenon that appears to be broken in a water containing glass with introduction template. Then, the delivery of learning objectives is also

presented by using introduction template. After that, the first material of refraction definition is conveyed through simple pictures by using introduction template, then students learn about refraction law which is delivered by using simulation template. This submenu consists of Willebrord Snellius images, texts about refraction, and an animation about refraction law. After that, the next material which is about refractive index formula and examples of the case are presented in simulation template. In the next submenu, students are exposed to the various refractive index materials through Table template. The material is continued on lens types which are displayed by using introduction template. The next page shows an animation about lens properties consisting of convex lenses and concave lenses through animation template. After that, three special rays on the lens are presented by using Click Table Animation template.

Before entering the formation of shadows on the lens material, students learn about spaces numbering in the lenses which is presented by using animation template. The learning is continued to shadow properties and formation on the lens which is presented by using Simulation template. Furthermore, an animation about focus of shadows which are formed on the screen is presented by using animation template. The study of refraction is completed with calculation on the lens material which presents applied formulas and sample problems by using animation template. The presentation about sample questions in refraction is continued on the demonstration template which presents some sample questions with discussion. The study of light refraction is ended by comprehension test presented by using demonstration template.

After you've finished developing your course, the LCDS gives you a few options for creating a distribution package. If you plan to host your course on a Learning Management System, you can create it as a SCORM package, which is a standard for e-learning content. Otherwise, you can copy the course files onto a CD or Web site. Based on the statement, we can know that there are four stages in writing the learning content on LCDS, they are create, review, refine, and delight. After finishing the development of a module with LCDS, LCDS will give some options to publish the product. If publishing the product on the Learning Management System is preferred, the files can be created in form of SCROM which is a standard on Learning Management System. The developed product can also be stored on CD.

The product of this development has some advantages, one of them is that this interactive module can be used as an alternative solution for students and teachers in facing the limitations of instructional media as well as providing a various and attractive learning resources in form of interactive module with LCDS program in Optical Geometry material for students. Students can learn independently to master Geometry Optical material, and this module is also completed with comprehension test in each sub material and the results can be automatically showed to the students, so that students know their abilities in mastering the material. This module is presented with multi representation by using text, image, symbolic, animation, and video which is presented attractively, so it is expected to be able to optimize the students' concept knowledge. The weakness of this interactive module is that it has not been developed to be accessed via online and every computer that is used to display this interactive module must install microsoft silver light. Another weakness of this module is the assessment for the student's learning achievements can not be done automatically. The assessment still has to be done manually, this is because the module has not been able to make an output in score list tablature form, and only limited to individual score.

Theoretically, the model of this electronic module can provide real problems that are packaged in multi representations in form of video, animation, or multimedia that give opportunity in providing the accessible and systematic material. Non-linear teaching materials provide students' opportunities in constructing meaning, providing lab models, and providing problem solving presented in hypertext, image, video, and animation, which can facilitate students in acquiring an understanding of concepts and learning achievements [23]. Deep understanding about the concept is the first step in the acquisition of the learning achievements.

4. Conclusion

It has successfully developed a product of electronic module design based on learning content development system in optical geometry material to cultivate students' multi representation skills. The developed product is designed by presenting the material with multi representation such as text, images, symbolic, video, and animation which are presented attractively.

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