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Development, interactive e-module, Transformation geometry.

ORIGINAL ARTICLE

Interactive E-Module Model Of Transformation Geometry Based On Case (Creative, Active, Systematic, Effective) As A Practical And Effective Media To Support Learning Autonomy And Competence.

This study aims to develop an interactive e-module of Transformation Geometry based on some principles, e.g. creative, active, systematic, and effective (CASE) as a teaching material to support learning autonomy and student's competence. In this research and development study includes some steps, e.g. preliminary study, product design and development (model), and product testing and assessment. In the preliminary study, based on student's needs analysis, it was shown that most students were more interested in Transformation Geometry session by using interactive emodule as the teaching materials as it may enable the students to learn independently and understand easily. Therefore, it is necessary to develop an interesting and easily-understood teaching material model in the form of an interactive e-module. In the designing step, the initial draft produced a model with a systematic: introduction (instructions for using e-modules, material descriptions, prerequisites, learning objectives), learning activities that include: a description of the material and examples of questions, problem training, summaries, competency tests, instructions for practice answers, feedback, and reference lists. In product development (model), CASE-based interactive e-module models covering Transformation Geometry topic was created. The results of the product review by experts indicate that the product (model) has fulfilled in terms of validity. The product testing results showed that the interactive e-module model Transformation Geometry developed in this study is as the teaching material model that supports learning independence and has met the criteria of a practical and effective model.

INTRODUCTION

The Transformation Geometry topic is one of the important information in Mathematics learning, and students of Mathematics Education study program at higher education level should master this material. The mastery of this topic is essential for the students as the prospective teachers who will utilize the materials as the bases for the teaching of Mathematic subject in secondary schools. Transformation Geometry is a field of Mathematics that develops intuitively concepts, theorems and algorithms. Transformation Geometry cannot be separated from deductive dedication of concepts, theorems and algorithms. Teaching the concepts of derivation deductively based on Transformation Geometry makes learning difficult and tedious. Therefore, in order to stimulate the students understand this course easily and independently, it is necessary to develop teaching materials that are easily learned by students independently, namely in the form of modules. With the module, the materials will be explained in detail and clearly, starting from the description of the material, examples of questions, summary of problem training, instructions for practice answers and competency tests so that students a easily understand the material of Transformation Geometry easily. To overcome the issues related to the use of learning resources, it is necessary to develop teaching material models that accommodate the different level of student abilities, supporting individuals to have autonomous learning habits, which may facilitate the students' learning. According to Dick and Carey (1990), learning materials should be applicable for all students so that they may learn on their own. These materials should provide opportunities for the students to learn without relying heavily on the explanation by the teachers, lecturers, or instructors. Modules can be categorized as media or learning facilities that contain materials, methods, limitation or scope of the learning materials, instructions for learning activities, exercises and how to evaluate those designed in a systematic and interesting way to achieve the competencies expected and used independently (Hamdani, 2011). The main goal of teaching materials in the form of modules is that readers are able to absorb teaching material or materials independently (Daryanto, 2013). According to Prastowo (2011), modules are teaching materials arranged systematically with easy-to-understand language so that students can learn independently with minimal help or guidance from educators. To reduce the saturation of students learning with modules and ease of access, modules need to be combined with electronic media, often called electronic modules (e-modules). Deep learning will be realized if integrated with e-modules and will produce a better graduate product.

The development of teaching materials in any form, including in electronic form, is intended to help people or facilitate students to learn effectively. Therefore, the development activities should be based on proper theories and analysis who will use (users) either for studying or teaching and learning activities themselves. In other words, understanding the users and learning activities is a fundamental requirement for each learning development activity. Good teaching materials provide tools that

make it easier for the users to see benefits and use them in practical way. Digital teaching materials in electronic form provide wide opportunities for innovation, even if only for small parts of the teaching materials (Prastowo, 2011).

According to Darmawan (2012), as the advancement of the science, technology and information brings new opportunities and shifts paradigms in terms of learning material and learning methods. Such products as the results of the advancement of technology and information have provided alternative teaching materials that can be used and accessed easily by students in digital forms such as e-modules. Computer-based interactive learning may enable the students to learn with high motivation because of their interest in multimedia systems. Wena (2010) reinforces this matter that learning that is able to utilize teaching materials integrated with computer media are believed to make more interesting and challenging learning process activities for the students. In addition, Prastowo (2011) asserts that interactive teaching materials should be creative, innovative and adaptive teaching materials for technological developments and should be able to make students happy and comfortable so that learning becomes more effective and efficient. According to Hamid (2012), learning requires fun and empowering engagement and interactions. Fun and empowering can be created by combining the principles of education and entertainment (wellknown with the terms of edutainment), so that students feel comfortable and not easily tired of learning. The form of entertainment in learning activities can be either in the form of objects, equipment or forms of activities that make students feel happy doing the learning activities. Munir (2013) added, learning activities that accommodate information and communication technology may help educators in conveying materials thoroughly and students in understanding the learning materials. With teaching materials with multimedia facilities including interactive e-modules, the material can be modified to be more interesting and flexible according to the needs of the learning context. Interactive e-module teaching material is one of the teaching materials of which the publishing process in digital form consists of text, images or combination of both. E-module is an electronic module which is presented systematically so that the users are able to learn and utilize the materials with or without a facilitator or teacher (Prastowo, 2011).

One of the criteria for the interactive emodule is self-instructional, which makes the teaching materials able to teach students independently (Asyhar, 2012). Development of CASE-based interactive e-module (based on the principles of creative, active, systematic, and effective) is teaching materials that may direct the students to learn creatively, actively, systematically and effectively so that they are expected to obtain knowledge and understanding of the materials to the fullest. Learning autonomy is promoted to the students with the intention that students have responsibility to regulate and discipline themselves (self-autonomy) and develop learning abilities on their own abilities. Such learning attitude should be possessed by students as it is indicated the maturity of educated people (Rusman, 2012). In independent learning context, the

students are required to understand the contents of the material outside the classroom by themselves, find their own sources of information, and solve their own difficulties. In learning, students should take the initiative to carry out their own learning activities. However, independent learning does not mean learning on your own. Learners may work, learn, and discuss with friends or other learning resources in solving the difficulties they are given. The purpose of this developmental research is the creation of CASE (Creative, Active, Systematic, Effective) interactive e-module for Transformation Geometry topic as alternative learning media that may support learning independence and student's competence in the Mathematics Education study program (higher education context), so that students are expected to learn easily, independently and interactively with fun.

METHODOLOGY

This is developmental research to develop and test certain products (Sugiyono, 2013; Borg & Gall, 1989). The benefits of the developmental research is to bridge the gap between researchers who produce educational theories and practitioners as the users of educational products (Abidin, 2016). In this study, the development model used was adapted and modified from the Plomp (1997) and Thiagarajan et al. (1974) models which included the following steps, e.g. preliminary studies, product design and development, and product testing and assessment. The subjects of the study were students of the Mathematics Education study program at the University of Islam Malang, Kanjuruhan University Malang, Institute of Teacher Training (IKIP) Budi Utomo Malang and Wisnuwardhana University Malang as many as 316 students and four Transformation Geometry lecturers respectively from the four universities. Data collection was carried out by some methods, e.g. questionnaires, literature review, documentation, and tests. Questionnaire was distributed to collect data on the identification of students and lecturers' needs related to the interactive e-module for geometry transformation topic (needs analysis). Literature review was conducted to review relevant theories related to learning media, modules, interactive emodule, and information and communication technology in learning activities. Documentation was done to trace and identify curriculum, particularly for the topic of transformation geometry. The tests were carried out to determine the effectiveness of the product (model). Data analysis techniques were both quantitative and qualitative analyses.

Quantitative analysis was in the form of percentage descriptive statistics (Sugiyono, 2013), while qualitative analysis in this model employed an interactive analysis model of three components of analysis, namely data reduction, data presentation, and conclusion and verification, of which the activities were carried out in an interactive form with the process of collecting data as a process (Miles & Huberman, 1986).

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FINDINGS AND DISCUSSION

In this developmental research to create the product in the form of interactive e-module for Transformation Geometry topic was conducted through some procedures, e.g. preliminary studies, product design and development, and product testing and assessment. The results of the research and discussion are described in accordance with these stages.

Results of Preliminary Study

This study involved 316 students and four lecturers from four universities in City of Malang, one of prominent education cities in Indonesia. The results of the questionnaire distributed to the 316 students and four lecturers during the preliminary study activities were intended to collect data on the identification of students and lecturer's needs. In addition, information related to students' characteristics and identification data of lecturer needs related to the subject of Transformation Geometry were also accommodated. The data collected from this activity were then used as the basis for product design and development of this developmental research. Needs analysis was conducted in order to fill the gap between the expectation and the actual conditions (Sanjaya, 2008). Needs analysis was carried out as a tool to identify current problems to determine the right actions given later. In this study, the identification of students and lecturers' needs was carried out to obtain information from the students and the lecturers about the Transformation Geometry material so far, whether there were problems and the main causes of the problems, whether the methods used by lecturers had been favored, and whether the solution to the material in the form of interactive e-modules was something needed, and so on.

Based on the results of the questionnaire of the needs analysis and the character of the students showed that 60.36% of students are happy with the Transformation Geometry subject. 71.30% of students want to study Transformation Geometry seriously and strive to improve their learning outcomes in this subject. To improve their competence, 71.89% of students expect various teaching and learning models employed by the lecturers in the classroom to avoid any boredom and monotonous activities in this subject. If the Transformation Geometry classes are developed in the form of interactive emodules, namely utilizing the computers and other information technology teaching materials, most of the students (54.58%) are very supportive, while others (41.75%) support the idea for the integration of interactive materials in the classroom. A very small proportion (3.85%) are less impressive as they confirmed they lacked mastery in information technology; they worried that the utilization of IT-based learnings might not affect their competence and they cannot operate the materials effectively. For the questionnaire for the needs analysis from the lecturers, it showed that most of the lecturers (75%) teaching the Transformational Geometry confirmed

the teaching and learning activities have been often dominated with one-way activities where students as learning objects, not the subjects. In relation with the development of interactive emodule for the Transformation Geometry materials, most of the lecturers showed positive attitudes (75%). With the findings above, it means that there is enough data corroborating the development of the interactive e-modules for the Transformation Geometry model. Even though some students showed lack of mastery in computer technology for the use of e-modules, this issue could be overcome by the developing e-modules which are simple to operate (user friendly technology). According to the data, in general, students suggest that it is necessary to develop such interactive teaching material media as part of the learning process that supports more effective learning and learning to promote autonomous behavior. The most interesting media for students, and as it is in line with the current trend, is media that integrates computer or information and technology (IT-based media). This is corroborated by the opinion of Rusman (2012) that computer is believed to stimulate students to be more active in learning and favored by students who can be used positively as learning tools. But in the implementation of the IT-based media, the presence of lecturers among the students is still considered important to supervise and facilitate the learning process, so that the division of lecturers and material roles becomes clear (Wena, 2010). By looking at the preliminary study, the development of this interactive emodule product is suitable for the students. The results of the identification of students' characteristics indicate that students' attitudes, interests, and motivations are generally positive towards the material of transformation geometry. This will greatly support the success of the product to be developed. The characteristics based on the students' attitudes who strongly support the development of interactive e-module products for Transformation Geometry subject are believed to facilitate and assist researchers in developing and implementing the development of the products. RESULTS OF PRODUCT DESIGN The product design phase included media selection activities, format selection, and creating the initial design of the product. Media selection was conducted to describe the media used to design the development of Transformation Geometry teaching materials and the selected media that were expected to facilitate the students to understand this teaching material. Based on the purpose of this study, the media used to develop this teaching material were interactive electronic modules (emodules). The format selection was carried out to describe the relevant format accommodated in developing teaching materials for the Transformation Geometry

subject. Based on the purpose of this study, the format used to develop teaching materials which focuses on creative, active, systematic, and effective (CASE). Creative means a series of content of teaching materials that directs the readers or learners (users) to be able to create their own various ideas to solve problems in the module. Active means the contents of the teaching materials require learners to actively develop ideas in solving problems so that learners are accustomed to active learning. Systematic means that every step in the teaching material is

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prerequisites, and learning objectives), learning activities which include material descriptions and sample questions, exercises questions (interactively), summaries, competency tests (interactively), exercise answer instructions, feedback, and reference lists. The initial design results in the development of teaching materials were used as the alternative to the students learning media in the Transformation Geometry subject, namely in the form of CASE-based interactive e-modules. The results of the analysis of learning materials lead to some learning topics, namely 1) Introduction (Vector, Matrix, Functions, Analytical Geometry); (2) Transformation Ideas, (3) Translation, (4) Half Circle; (5) Reflection, and (6) Rotation.

Results of Product Development

At this stage, product development was done by developing products by paying attention to the results in the design procedures. This is consistent with the opinion of Seels and Richey (1994) who state that development is a process of translating or describing design specifications into physical form, or in other words, development means the process of producing learning materials. At this stage, product development was carried out by referring to the process of drafting CASE-based interactive e-models for transformation geometry. The e-modules were arranged in a complete, clear and interesting manner, so that it is easier for the students to study independently, not being depend on others. The emodule was created using the Kvisoft Flip Book Maker program and Quiz Maker program which are able to create an e-module display such as the print module display. The emodules were packed in the form of CDs which are accompanied by instructions how to use the media (manuals). E-modules can be operated in offline mode on a computer that has Adobe Flash Player software installed. This e-module has the characteristics as a learning module with some components, including introduction (introduction, instructions for using e-modules, description of material, prerequisites, learning objectives), learning activities include: material description and sample questions, problem training (interactively), summaries, competency tests (interactively), practice with answer instructions, feedback, and reference lists. The final result of this stage is the compilation of CASE-based (creative, active, systematic, and effective) interactive emodule for transformation geometry. The

presentation the emodules is in the form of CDs with instructions (manuals) how to use the media. E-modules can be operated offline using a computer. The results of the development of e-module Transformation Geometry include: outer cover, inner cover, initial appearance: preface, instructions for using e-modules, and components of each module containing introduction, learning activities which include material descriptions and sample questions, practice questions (interactively), summaries, competency tests (interactively), feedback, and reference lists.

This Transformation Geometry e-module discusses six learning module units, namely modules for (1) Introduction (Vectors, Matrix, Functions, and Analytical Geometry), (2) Transformation Ideas, (3) Translation, (4) Half Circle, (5) Reflection, and (6) Rotation. The materials were arranged with the objective to facilitate the students in understanding the materials of transformation geometry. This is in accordance with Munir's statement (2013) stating that the module in learning has some pivotal roles, namely (a) explaining learning materials or abstract objects that become concrete, (b) enabling the students to learn the material repeatedly. Learning material can be repeated at another time without having to make it again, (c) overcoming the limitations of time, space, and sense power, both students and lecturers, (d) increasing learning motivation and passion of the students, (e) developing the ability of students to interact directly with the environment and other learning resources, (f) enabling the students to learn independently according to their abilities and interests, and (g) allowing the students to measure or evaluate their own learning outcomes.

Results of Product Testing and Evaluation (Model)

Testing and evaluating product quality were done by testing and assessing the validity, practicality and effectiveness of the model (product). The assessment of product validity was carried out by involving the relevant experts namely experts on learning design, multimedia learning, and content expert on transformation geometry. The product validity assessment was carried out by experts through a questionnaire for validity assessment of the product. The results of the analysis of product validity assessment by experts, namely content expert on Transformation Geometry material obtained a score of 3.33, the assessment of learning design expert obtained a score of 3.42 and multimedia expert obtained a score of 3.28. On average, the three experts

obtained an average score of 3.34 (high). The score shows that the interactive e-module model produced has met the product validity requirements (models). The testing and evaluating practicality of the product were carried out by four practitioners (lecturers) teaching Transformation Geometry from different universities. The practitioners tested the product (model) and assessed the practicality of the product through a questionnaire for product practicality assessment. The results of the product practicality assessment analysis obtained an average score of 3.31 (high). The score shows that the interactive e-module model produced has met the practicality requirements of the model. The interactive e-module for Transformation Geometry model has been tested by four users (practitioners) or lecturers whose expertise on the area of transformation geometry. Through the questionnaire instrument, the users (practitioners) stated that the model is interesting and can be used or implemented in the Transformation Geometry classes. This is in accordance with Nieveen's opinion (1999) that a model is believed to be practical if the users (practitioners or lecturers) consider the model developed as interesting (fun) and can be used or implemented in learning process. Testing and evaluating the effectiveness of the product was conducted by testing the students' performance through quasi-experimental trials in the pretest-posttest groups (matching pretest-posttest group design) and evaluating students as product users through questionnaire instruments. The trial was conducted on a group of 62 students, selected through paired samples. Before the product trial was conducted to the students, the students were given the initial test (pre-test). After the product trial was done by the students, then the students were given the final test (post-test). The requirements that must be fulfilled before carrying out the t-test are the data should be on normal distribution (Sugiyono, 2011; Sukmadinata, 2012).). The results of the normality test data through testing the normality of Shapiro-Wilk data using SPSS 19.0 at a significant level $\alpha = 0.05$ showed that the data were normally distributed (S-W = 0.749, dk = 62, p = 0.058) (Santoso, 2009). Data analysis was performed with SPSS 19.0, obtaining the average pre-test score of 62.27 and the post-test average score of 73.48. The results of paired sample t-test showed t score of = -7.25 with a significance level of 0.002. As the t score was smaller than 0.05, meaning that Ho is rejected or there are differences in the average score of students' performance during pre-test and post-test (Santoso, 2009). From these results, it is indicated that the use of interactive e-module for Transformation Geometry topic improves students' learning outcomes. In addition, the results of product assessment

by the students obtained through questionnaire instrument showed an average score of 3.21 (good to high). Based on the assessment score, students in general have good and positive attitudes on the use of the interactive e-module for Transformation Geometry model in the classroom. Based on the results of the testing on the effectiveness of the products through quasi-experimental trials and product assessment by users (students) through questionnaire, the product gained good results in general. These results indicate that the interactive e-module model produced has met the requirements of model effectiveness. This is in accordance with Nieveen's opinion (1999) that a model is considered effective if the operational model gives such results as expected, namely to achieve learning goals with good results; students' learning outcomes showed improvement, and students' responses toward the implementation of learning by using the e-module showed good/high results). Based on the results of the testing and evaluation on the quality of the product, it is in accordance with Nieveen's theory (1999) that, in developing the model, it is necessary to evaluate the quality of the product (model) by testing and assessing the validity, practicality and effectiveness of the model (product).

Conclusion and Suggestion

This is developmental research which covered some procedures including preliminary study, product design and development, and product testing and assessment. The results in the preliminary study phase in the form of students' needs analysis showed that most students (in general) are more interested in the use of the interactive e-module for Transformation Geometry subject as they believe it allows students read and experience autonomous learning habits. Therefore it is necessary to develop easy-to-understand teaching materials, namely interactive e-module for transformation geometry. The results of the design phase for the initial draft of interactive e-module for Transformation Geometry contain the following systematic, e.g. introduction (introduction, manuals how to use the e-modules, description of materials, prerequisites, and learning objectives), learning activities which include material description and sample questions, problem training (interactively), summary, competency test (interactively), exercise with answer instructions, feedback, and reference list. During the product development phase, the interactive e-module prototype was prepared, namely the formation of the interactive e-module based on

some criteria, e.g. creative, active, systematic, and effective (CASE). The interactive e-module draft was designed and developed systematically by adhering to the principles of learning development. The product validity was reviewed by some experts on respective area, showing that the product has shown valid score of 3.34 (high). The results of product testing showed that the interactive e-module model has met the practical criteria score of 3.31 (high) and product effectiveness, with sig. value of 0.002 (

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