THE DEVELOPMENT OF CABRI 3D BASED LEARNING MATERIAL THREE DIMENSIONAL AT CLASS X HIGH SCHOOL

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Abstract

This study aims to (1) produce teaching materials based Cabri 3D material Dimensions Three Dimensions which is valid, practical, has a potential effect on the achievement of learning and explain the process of development, (2) describe the characteristics of teaching materials based Cabri 3D material Three Dimensions. In developing teaching materials, researchers through the preliminary stage and prototyping with groove formative evaluation. In the prototyping stage researchers involved class X SMA Xavierus Lubuklinggau. Data collection techniques used are documentation, walk-throughs, and the results of the test. This research-based teaching materials Cabri produce 3D material Three Dimensions valid and practical, and has a potential effect on the achievement of learning and self-sufficiency indicators of student learning. Validity of instructional materials in terms of compliance with the curriculum and the results of expert validation and test prototypes at the stage of a small group. The potential effect of this teaching material visible from the ability of students determines the position, distance and angle of the elements of geometry. The results of the evaluation study shows 3.13% categorized as excellent value, 56.25% as good, 34.38% as sufficient, and 6.25% as less. From the observation unstructured during the learning process of students have the initiative to learn and utilize learning resources.

Keywords: teaching material, Cabri 3D , three dimensions

INTRODUCTION

Geometry is defined as a branch of mathematics that studies about points, lines and areas of space objects and their properties, the measurements and their relationship each other (Xavier, 2008: 2). At the high school level especially in Indonesia, expected competencies in learning geometry includes: identifying a planes and solids according to the properties, elements or similarity; performing arithmetic operations involving perimeter, area, volume, and unit of measurement; estimating the size (e.g. length, area, volume) of objects or geometry; applying the concept of geometry in determining the position of the distance, angle, and transformation in problem solving (Depdiknas, 2004).

According to Clements and Battista (1992) learning objectives of geometry is to develop the ability to think as a foundation for the real world, and to convey the knowledge needed in geometry and to teach how to read and interpret mathematical argument. The competition required that the students have the ability to acquire, manage, and use information to face the future is always changing, uncertain and competitive.

Geometry has a big opportunity to be learned by the students, because it has a number of application in daily life. However, based on Sunismi & Mulin (2012), the students still encounter difficulties in learning geometry. According Strutchens, Harris & Martin in Nooraini (2004) students learn geometry by memorizing geometric properties rather than by exploring and discovering the underlying. Such geometrical knowledge is very limited and superficial, for example if students memorize that square has four equal sides, they will be unable to distinguish between a square and a rhombus. Eventually these students find difficulty in applying that limited geometry in problem solving.

Problems in learning the geometry of three-dimensional in particular with regard to the way students to construct solids geometry, as disclosed Kariadinata (2010) that in solving three-dimensional geometry problems, visualization is important. However, the students find it is difficult to represent and interpret object, even for two-dimensional images. The similar problem occurs in some secondary schools class X Lubuklinggau that researchers get by interviews with teachers stating that the student level of abstraction of objects and properties in particular geometry of three-dimensional shapes is still low. This is evident from the inability of students to distinguish plane diagonal and the diagonal plane a geometry, determine the base and the roof of a cube of a webs.

Solve the above problems, the theoretical learning geometry according to Bruner in Dahar (2006) must go through three stages: enactive, iconic and symbolic. According Hiele in Abdussakir (2009) in learning geometry must be adapted to the stage of development of thinking, namely: stage visualization, analysis phase, the stage of formal deduction, the deduction phases and stages of rigor. The second theory suggests that in learning geometry must begin by showing real objects directly, either in the form of massive objects or using computer media, then proceed with the next stage in accordance with both the theory.

Based on observations and interviews, while learning the geometry of the steps taken by the teacher is using the teaching aids in the form of skeleton the shapes space, but this way face constraints due to the limited concepts can be explored as well as the impracticability of props given size is big enough. Thus necessary teaching materials that can overcome the problems that occur are the teaching materials that integrate computers in the classroom and can be accessed online so that it can replace the role of props in the form of visualization solids space and can encourage students to use learning resources other than books.

Based Permendiknas No. 22 of 2006 on the Content Standards states that to improve the effectiveness of learning, is expected to use information and communication technologies such as computers, teaching aids, or other media. Technology and the media can contribute a lot to learn, if the teacher-centered teaching, technology and media support teaching presentation, otherwise if student-centered teaching, the students are the main users of technology and media (Smaldino, Lowther, & Russell, 2011). Referring to the draft curriculum in 2013 which stated by Kementerian Pendidikan dan Kebudayaan

Indonesia (Indonesian Ministry of Education and Culture), that in any learning process should be integrated with ICT. Through the use of ICT each student will be motivated to learn advanced sustainable in accordance with its potential and proficiency, so it would appear the initiative to learn. Thus the technology and media can help teachers be creative manager of the student learning experience rather than a transmitter of information.

The role of technology and media in learning geometry lies in the visualization. Some mathematics educators Chong (2001), Del Grande (1987) Kor (1995), Young (1987), Usiskin (1987) recommends reproduce visual activity in the classroom to help students understand the concept of geometry (Noraini, 2004). Educational organization National Council of Teachers of Mathenatics establish technology as one in six school math principles, namely Technology is very important in the learning process of mathematics, influence on mathematics is taught and engage students in learning (NCTM, 2000).

Some media that can be used for learning math, especially geometry them, Geometry Sketch Pad, GeoGebra, Cabri II Plus, Mat Lab, Maple, and Cabri 3D. Learning problems in this study relates to the three-dimensional geometry, then the media will be used is Cabri 3D. Cabri 3D is a software specially developed by educators, mathematicians to help the learning process geometry (Cabri, 2012). Cabri can open up opportunities for students to learn to build his knowledge of geometry after observation, exploration, experiment and hypothesized to further the formal proof that ultimately can be applied in solving geometry problems (Sabandar, 2002).

Based on the results of research on the effects of the use of technology in mathematics instruction conducted by Mazas and Arias in Spain for 6 years which involved 15,000 students and 400 teachers, shows that there are differences in the ability of 30 percent of students who used Cabri compared to students in control classes that do not use software (Cabri, 2012). According to Lima (2000) there are significant differences students who were studying geometry using a pencil and paper with learning using Cabri, it is seen from the way they answer the question, that reconstruct or visualize the problem in question before the count (Cabri, 2012).

According Siswanto (2011) Cabri 3D software give effect to increase the ability of the three-dimensional geometry problem solving and motivation of high school students. Budiman (2011) in his research suggested that the increased ability of creative thinking that gets students' mathematical problem-based learning approach aided Cabri 3Dbetter than students who received conventional learning. In contrast to previous studies, Supriyono (2012) conducted research on the development of teaching materials and concluded that teaching material based geometry Cabri 3D has potential effects on student learning outcomes.

Based on the description of the theory and the problems described above, the authors consider it necessary to conduct research related to the utilization of information and

communication technologies, especially the media on learning high school mathematics. The authors develop Instructional Materials Cabri 3D Based atl Class X High School.

THEORETICAL FRAMEWORK

Teaching materials is a set of tool/material which contain knowledge, skills, and attitudes that are arranged in a systematic and attractive and adapted to the development potential of learners in order to create an atmosphere that allows learners to learn, so the learning objectives defined by the standards of competence can be achieved.

According to the Ministry of Education (2004), some components of teaching materials that can be said to be good, among others, contains instructions to learn (instructions learners/teachers), the competence to be achieved, the contents of the subject matter, supporting information, exercises, manual work (can be a sheet employment), evaluation, and response or feedback to evaluation. Meanwhile, according Padmo (2004) is a good teaching materials teaching materials which contains a good illustration, designed well, then validated by engaging experts, to be tested properly.

In particular the geometry of teaching materials, theories underlying the systematic delivery of material geometry refers to 1) Jean Piaget's theory of cognitive development, 2) the theory of the development of Jerome Seymour Bruner, 3) Van Hiele's level of thinking, 4) learning experience by Edgar Dale. The fourth theory requires that the teaching of geometry must begin with the stage of visualization, in this case we need multimedia, for instance Cabri 3D program. Thus the geometry learning objectives can be achieved.

METHODS

This research is a type of Formative Evaluation Developmental Research using qualitative descriptive data analysis techniques and quantitative. Research development according to Seel & Richey, Akker & Plomp in Hadi (2002) is a systematic study of the designing, developing and evaluating program processes and learning products that must meet the criteria of validity, practicability, and effectiveness. While the formative evaluation according to Akker (1999: 6) is a research activities carried out during the entire development process of a particular intervention, which aims to optimize the quality of the intervention as well as the principles of testing a design.

This research aims to develop teaching materials by following to Tessmer (1993) two main stages of research development that preliminary study phase (phase of preparation and designing) and formative evaluation (phase evaluation and revision). Following the steps of the development of teaching materials based Cabri 3D three-dimensional material at a formative stage evaluation is based on Figure 1.

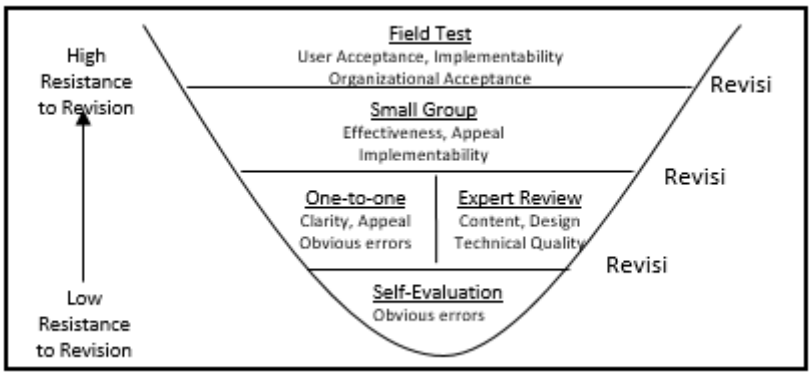

Figure 1: Flow design formative evaluation (Tessmer, 1993)

Data collection techniques used in this study consisted of a walk-through, observation, documentation, and testing. These techniques are used to determine the effectiveness, efficiency and practicality of teaching materials developed (Tessmer, 1993). During the expert-judges evaluation, all comments submitted by experts are used to revise the prototype. Observation is used to observe the students' learning process when using teaching materials provided in one to one, small group, and a field test to determine the practicality of teaching materials. Documentation conducted from the design stage, self-evaluation, one to one, small group and field test. The test is used to obtain data about the effectiveness or potential effect after participating in learning activities with Cabri-based teaching materials Three Dimensions 3D material.

The data obtained during the study will be analyzed qualitative- and quantitatively. Qualitative descriptive analysis was used to analyze the practicality of teaching materials obtained by observation and findings on small group learning, knowing the location of student difficulties in understanding the direction and guidance contained in teaching materials, and determine the effectiveness of the teaching materials developed. Quantitative descriptive analysis to analyze data derived from an average of exercises, the average value of a competency exam, and the value of daily tests. These data are processed to determine the category of learning outcomes of students. Formulas and categories for the calculation of the final value as follows:

$$N_A = \frac{2L + 3U + 5U}{10}$$

N_A = Final Score
T = The average score of exercise
H = The average score of the competency test
U = The score of daily test

(Modified from Sudijono, 2009)

Criteria for the final score of each learner interpreted using categories such values in Table 1.

Table1: Category final score of Students

Score	Category
$80 \leq N_A \leq 100$	Very Good
$66 \leq N_A \leq 79$	Good
$56 \leq N_A \leq 65$	Pretty
$40 \leq N_A \leq 55$	Lack
$N_A \leq 39$	Failed

(Modified from Arikunto, 2009)

RESULT AND DISCUSSIONS

Development of teaching materials include two stages, namely the preliminary study (preparation phase and stage of designing materials) and formative evaluation (phase evaluation and revision). The preparation stage includes the study of literature, curriculum analysis, analysis of learning resources, and instructional materials selection or determination. Stage designing materials to produce teaching materials in accordance with the principles of learning and include among others: 1) instructions to learn, 2) competence to be achieved, 3) content, or content learning materials, 4) supporting information, 5) exercises, 6) work instructions, and 7) evaluation.

Formative Evaluation includes the step of self-evaluation, expert review, one to one, revision, small group, revision, field test. Step or groove formative evaluation in accordance with Figure 1. The following are expert comments or suggestions given validator to the expert test phase as shown in Table 2 below.

Table 2: Comments or suggestions validator

No	Validator	Comments / Suggestions
1	Muhamad Yusup, M.Pd.	i. In the learning objectives using operational verbs so that the goal can be measured or assessed. ii. Serving/Construct learning materials is good iii. Frontal angle in a three-dimensional image of more than 30^0 and less than $45^0 (30^0 < \alpha < 45^0)$
2	Aljupri, M.Sc.	i. Instructional materials no page numbers, page numbers needed to facilitate the reader. ii. Most images have a serial number of images, some others do not have the serial number of this reduces the readability of comfort and clarity in teaching materials. iii. Command matter "mentioned" good substituted "write", because "say" is a command that can be done verbally (not written)
3	Muda Nurul, M.Sc.	i. Teaching materials is good enough, sequentially, completeness of the contents, and the truth. ii. Before the definition of the material to be conveyed, reaffirmed that we want to give apperception,

No	Validator	Comments / Suggestions
		apperception coupled with the problems of everyday life. iii. More highlighted again the use of Cabri 3D.

Teaching materials developed after a test phase experts, one to one, and small group generates a second prototype. Then, the second prototype was revised with changes as shown in Table 3.

Table 3: Comparison of the second prototype revision

Before Revision	After Revision
Concept maps does not exist	Concept maps are added on the early page so that students get a general concept of the material geometry
The word "angle" mentioned in question number 1 page 6 makes students confused	The word "angle" is omitted, so that students can answer in accordance with that referred to in the question
There are some images that were not given the information so it looks inconsistent	Each picture is captioned to look consistent and relevant to the topic being discussed
Competency test only in KD1	Competency test added to each KD (1,2, and 3) to determine the extent of achievement indicators of students after learning
No conclusions	Conclusion added at the end of the teaching materials to facilitate student understanding

Next, the third prototype is tested in the field test, which was involving 32 students of class X SMA Xavarius, Lubuklinggau. Field Test aims to determine the effectiveness of teaching materials produced, according Rochmad in Putri (2011: 245) relating to the effectiveness of teaching material impact on activity and learning outcomes. In the research development of teaching materials, teaching materials indicators to express said to be effective, for example, seen from the components: 1) the study of students, 2) the activities of learners, and 3) the response of learners. Components effectiveness observed by researchers to see the potential effects are: 1) the learning activities of students during the trial, and 2) the results of the students' answers expressed by certain criteria.

During the learning process of students directly interact with the teaching materials with the aid of figures with Cabri 3D program, while teachers act as facilitators, learning activities as shown in Figure 2.

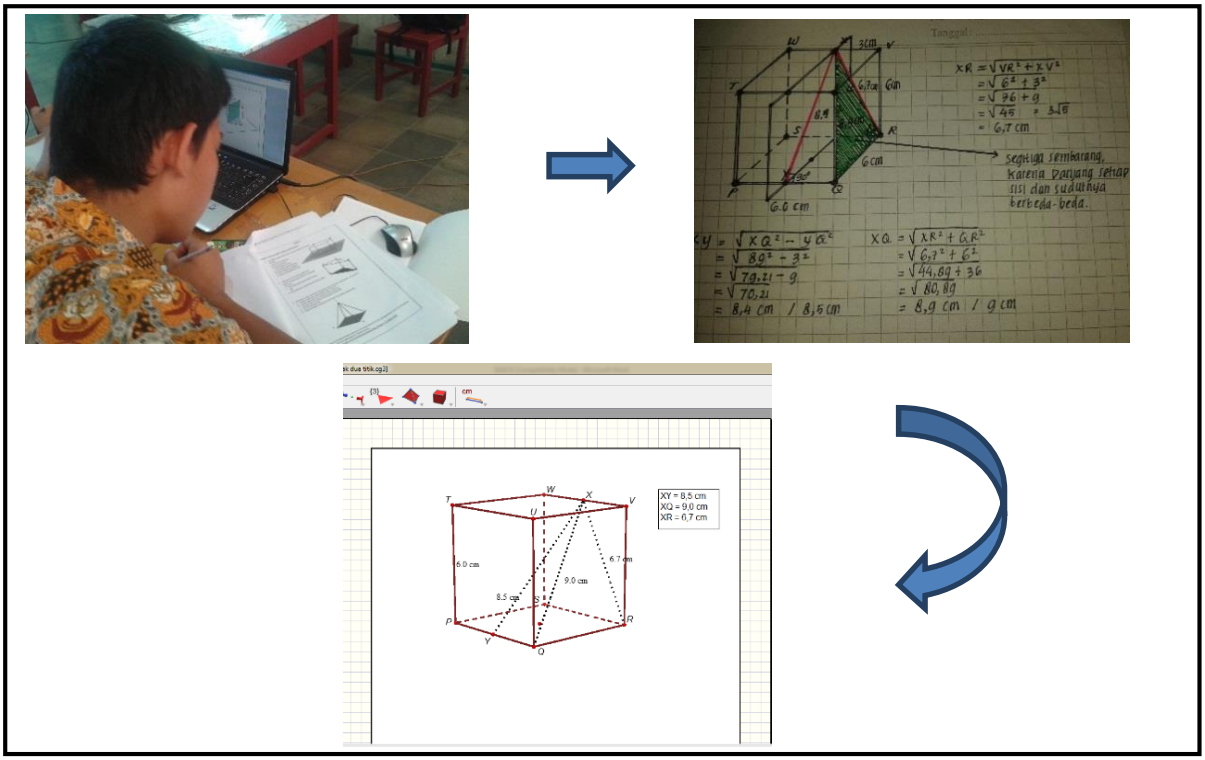

Figure 2: Activity of Student Learning

Figure 2 shows that the students construct an image that is in question, then perform calculations using the Pythagoras theorem, match the images and the calculation results with those obtained through the Cabri 3D program. This makes students become more enthusiastic to learn the material contained in teaching materials, because students can directly evaluate the results of his work, so students can know how far his understanding of the material being studied. In line with the opinion of Siswanto (2011), Cabri 3D program to give effect to increase the ability of the three-dimensional geometry problem solving and learning motivation of high school students.

After all lesson were conducted, we check the students understanding using a post test. The following table 4 shows the stundent achievement on the test.

Table 4. Evaluation of learning outcomes

Criteria	Number of students	Percentage	Category
$80 \leq N_A \leq 100$	1	3,13	Very Good
$66 \leq N_A \leq 79$	18	56,25	Good
$56 \leq N_A \leq 65$	11	34,38	Pretty
$40 \leq N_A \leq 55$	2	6,25	Lack
$N_A \leq 39$	-	-	Failed

Besides the data from table 4 showed, the understanding of the learners can be seen of how to answer problems contained in teaching materials. See Figure 3.

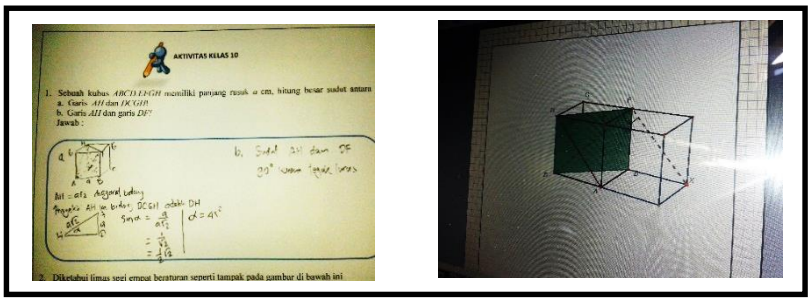

Figure 3. Students' answer while working on activities 10

Refer to the figure 3, shows that the number 1.A students to determine the angle formed between the lines AH and DCGH of calculations, the answer angle is 45^0, students understand the projection lines trigonometric angle to the plane of comparison. In addition to the answers of other students looking to other alternatives, namely because AH lies in the field of ADHE and intersect with the fields at DH DCGH the half angle of the corner of ADH is 45^0. Problem solved 1.b number of students with the help of Cabri 3D, students draw two cubes adjacent to determine the angle between AH and DF, steps taken by the students is projected to FX AH line, then look for an angle that is 90^0. Steps taken by the students shows that students can determine the position between the two lines and were able to find the angle between two lines.

It can be concluded that the third prototype three-dimensional teaching materials based material Cabri 3D is being developed have the potential effect toward student learning outcomes.

CONCLUSION

The research has resulted in a product in the form of teaching materials based Cabri 3D three-dimensional material to train independence of class X student Lubuklinggau Xaverius High School. Based on the results of research and discussion we concluded:

1. Characteristics based teaching materials Cabri 3D three-dimensional material which is valid and practical are as follows :
   a. Feasibility contents of teaching materials adapted to SK, KD, and learning objectives, is students learn and explore the concept of three-dimensional materials related to the position, distance, and big angle involving points, lines, and areas in three-dimensional space. Prerequisite knowledge or skills in the use of Cabri 3D program in the form of video tutorials and exercises students can access through a library Edmodo. Exploration of matter that require visualization assisted by Cabri 3D program. Teaching materials using clear language and do not have a double meaning. Graphic illustrations, drawings and photographs shown to support the explanation of the material in teaching materials.
   b. During the students use learning materials in the learning process, the students did not encounter significant difficulties, so that it can combine the utilization of instructional materials and programs Cabri 3D in studying and solving the problems related to the three-dimensional material.

2. Based on the development process showed that the prototype has been developed teaching materials have potential effects, it is seen when students are able to: 1) determine the position of points, lines, and areas in three-dimensional space; 2) determine the distance from the point to the line and from the point to the field in three-dimensional space; 3) determine the angle between the line and the field and between the two fields in three-dimensional space.

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