ICT media design for higher grade of elementary school mathematics learning using CS6 program

M Zainil¹, R C I Prahmana², Y Helsa¹ and S Hendri¹

¹Universitas Negeri Padang, Jl. Prof. Dr. Hamka Air Tawar, Padang, Indonesia
²Universitas Ahmad Dahlan, Jl. Pramuka Kav. 5, Pandeyan, Yogyakarta, Indonesia

E-mail: melva_zainil@yahoo.com

Abstract. Technological innovation contributes to the emerging of new possibilities to change the learning process. The development of technology could bring the higher quality of education through the integration of technology in the learning. The purpose of this research is to create an interactive multimedia using CS6 program for mathematics learning in higher grade of elementary school. It was a development research using ADDIE model which consists of analysis, design, and evaluation stages. It has successfully developed interactive multimedia in a form of learning CD used in the material of plane figures and solid figures. The prototype has been validated and then tested for the 4th grade of elementary schools. Two schools were involved and the students taught by utilizing the prototype, and then, in the end of learning, they are examined to determine the learning result. There were 72% of the students passed the examination as they classified at good and excellent categories. Finally, the use of CS6 program is promising to help the students learning plane and solid figure in mathematics learning.

1. Introduction

Learning process requires a smooth communication between teacher and students. In order to avoid or reduce the possibility of miscommunication between them, a tool such as media is needed to help the communication process. The teacher can improve the quality of the lesson when supported by various forms of media [1]. As a means to communicate in teaching and learning activities, the presence of media is inevitable. The use of appropriate media in the learning process will help students to receive the material and increase the interest of students to the lesson [2].

Geometry is one of the mathematics topics introduced to elementary school students. The students will be introduced first to planes, then the students will get an explanation about solids. Since we talk about geometry in elementary schools, then the representation would be close to the children surrounding objects [3]. The solid material plays an important role in the development of science of technology. Various kinds of solid learned in elementary school such as: cube, cuboid, prism, cylinder, pyramid and cone [4].

Some solid concepts are difficult to understand by elementary school students. This happens because elementary students are still at a concrete operational stage according to Piaget [5–7]. However, most of mathematics teachers in elementary school teach solid concepts in an abstract way and less multimedia used. The use of concrete objects and virtual manipulative are promising to help students understanding mathematics concepts [8,9], including solid. The virtual manipulative is the multimedia that can be used, utilizing information technology (IT). By leveraging various IT advantages, it can
improve students' ability to understand mathematical concepts, procedures, and algorithms. The presence and advancement of IT in today's global communications era has provided an opportunity and expansion of learning resources that can occur anytime and anywhere without being limited by space and time [10]. With the help of IT, the material presentation process can be more interesting and fun. On the other hand, the presence of IT challenges teachers in a professional way to be able to manage information so they can choose the media and utilize IT effectively and efficiently in the learning process. This is in accordance with the demands of the 2013 Indonesian Curriculum, where this research area focus on, to encourage teachers use IT as a tool or media in helping students to understand the material.

The development of IT has enriched sources and learning media in various forms such as OHP Transparency, Power Point Slide, Image, Animation, Film/Video, Hypertext, Webpage, Computer aided learning program, and Software supporting learning applications such as Macromedia Flash, Camtasia, Maple and CS6. Professional teachers have been able to choose, to develop, and to utilize various types of learning media in order to ease the delivery of teaching materials and to help students understand the materials [11]. The advancement of IT has also enabled the utilization of various types of media simultaneously in the form of multimedia learning. The use of interactive multimedia that includes audio-visual components (voice and display) for the delivery of learning materials can attract students to learn. Interactive multimedia can also provide opportunities for students to conduct pseudo-exploratory experiments so as to provide a learning experience rather than simply listening to the teacher's description and explanation.

Based on our observations towards several elementary schools in Bukittingi, such as SD Sabbihisma and SD Negeri 20 Kurao Pagang, we found that the utilization of multimedia in the schools was not massively used. Both of the schools have background of parents who classified as upper middle economic level and there are many students are accustomed to using technology tools such as I-pad. Furthermore, we found that in SD Negeri 20 Kurao Pagang, each classroom has been equipped by 20 sets of computer. The school has 18 teachers, they were not skilled in using any gadgets.

We also conducted observation at SD Negeri 05 and 09 Bukittingi. We found that similar phenomena happened in the two schools. The schools have been equipped with the multimedia supported classroom, but the teachers werenot skilled in using it. Such phenomena became challenges for us to develop the use of IT in mathematics learning at the schools. In order to help the elementary school teachers to master using IT tools in the solids learning process, in order to not just teach but make the students learn and to be motivated to learn, it can be done with the use of media-based learning media IT such as CS6 program.

The learning activities by using IT media-based learning is one of the teacher concern so that the students get ease to learn the solids material and the students are motivated to learn well. While the reason of using Macromedia Flash because it is easy to be made as a media, and Macromedia Flash media can also be animated. By using CS6 program, the students are expected to be free to learn planes and solids material anytime and anywhere without a certain time limit. The students will be able to learn by using technology tools they have such as I-pad and so on and the teachers are increasingly professional in using technology tools in addition to their profession as educators.

2. Method
This type of research was a developmental research using qualitative and quantitative descriptive data analysis techniques. The development of IT-based multimedia is an activity to develop the media for mathematics learning especially in the material of solid which includes content and procedure, and the presentation in a form of interactive CD using CS6 program as the software.

It was a development research using ADDIE model which consists of analysis, design, and evaluation stages [12]. It has successfully developed interactive multimedia in a form of learning CD used in the material of plane figures and solid figures. The prototype has been validated and then tested for the 4th grade of elementary schools. Two schools were involved and the students taught by utilizing the prototype, and then, in the end of learning, they are examined to determine the learning result.
3. Results and Discussion

The research began with an informal observation in SD Sabbihisma, SD N 20 Kurao Pagang, SD N 5 Bukittinggi and SD N 9 Bukittinggi. They are elementary schools in West Sumatera. We observed computer laboratory and the students and teacher's computer skill. Further, there were 3 stages performed in this research: analysis, design, and evaluation.

3.1. Analysis Stage

Analysis stage was conducted in a form of media program outline analysis. The analysis included two steps, they are: (1) analysis on the curriculum material and (2) learning objectives. The analysis on curriculum material was conducted to select and to adjust the material of plane figure and solid figure in order to be appropriately relevant with the Indonesian 2013 curriculum. Further, identification and selection of material which is relevant to the interactive multimedia was conducted such that the basic competence of the curriculum can be achieved. These analysis result on the formulation of learning objectives. It was to understand the forms of plane figures and solid figures. In this stage, limitation of material on the interactive multimedia was determined. This stage also determined what materials can be geometrized either in the form of animation or simulation.

3.2. Design Stage

In the design stage, we create flowchart to determine the path of research. Flowchart is a program flow made from start, content to exit / exit program; scenario was clearly illustrated in flowchart. Creating flowchart involved the following steps.

3.2.1. Making storyboard. Before creating a storyboard, the researchers did a paper based stage. This stage contained a design that started from the sketch of the image on the paper. After designing in paper-based form, it was proceed to make storyboard. The storyboard was a description that contained the visual and audio explanations of each flow in the flowchart. One column in the storyboard represented a single display on the screen. This stage aimed to get a description of the form and what was displayed on the macromedia flash. The design consisted of main menu and support menu. The main menu consisted of purpose, material, sample questions, simulation and evaluation, while the support menu consists of help feature. Here is the example of the menu provided in the media as shown in Figure 1.

![Figure 1. Some menu buttons in the interactive multimedia](image-url)
3.2.2. Computer designing. This stage was included the creating ideas from the storyboard to the computer. It was divided into two stages: (1) Collecting the materials needed to complete the interactive multimedia presentation. Materials that need to be prepared included video, sound, animation, and images, (2) assembling all the existing material.

An interactive multimedia was one of the media that was able to present learning materials presented in a systematic and concrete way, making it easier for the students to understand. Prototype 1 of the initial design of interactive multimedia is shown in Figure 2.

![Prototype 1 of the initial design of interactive multimedia](image)

Figure 2 (a, b, c, d). Prototype 1 of the initial design of interactive multimedia

Figure 2 shows that prototype 1 has already focused on three main characteristics (content, support and lay out). The content consisted of chapters, sub-sections, paragraphs, and others about matter recognizing planes and solids form, structure was reasonable and flowing and explained from chapters and sections above. Lay out has already contained visual aspects such as images, graphics, colors and interactive and there is already granularity or icons connected with free and structured hyperlinks and used to fragment text in chapters and sections.

Van Hiele stated that there were five stages of the student learning in learning geometry, namely: introduction, analysis, informal deduction, deduction, and accuracy stage described as follows: (1) Introduction (visualization). In this stage, the students began to learn about a form of geometry as a whole, but had not been able to know the properties of the geometry that they saw; (2) Analysis. In this stage, the students started to recognize the properties possessed geometry objects that observed. The students were able to mention the regularity contained in the object of the geometry; (3) Informal Deduction. In this stage, the students begun to be able to carry out the conclusion that was known as deductive thinking. But this ability was not fully developed yet. One thing to note here that was the students at this stage started to do informal deduction; (4) Deduction. In this stage, the students was able to get conclusion deductively, namely the conclusion of the things that were general to the things that
were specific; (5) Accuracy. In this stage, the students begun to realize how important the precision of the basic principles underlying a proof. For example, the students knew the importance of axioms or postulates of geometry Euclid. The accuracy stage was a high stage of thinking, complicated, and complex. It was therefore not surprising that some university students, even though they were already in high school before, yet they still have not reached this stage of thinking [13].

Each stage in Van Hiele's theory showed the characteristics of students' thinking processes in learning geometry and their understanding in the context of geometry. The quality of student knowledge was not determined by the accumulation of knowledge, but it was more determined by the geometric thinking process used. The stages of Van Hiele's thinking would be followed and passed by the students in sequence. Thus, the student must pass through a stage well before going to the next stage. The speed of moving from one stage to the next stage was depending on the number of the content and method of learning used, rather than on age and maturity. Thus, the teacher must provide a learning experience that matched the student's thinking stage. On the other hands, some research already documented that explain about mathematics learning experience to support this research result [14-17].

3.3. Evaluation

In this stage, these pre-designed products were evaluated. In this evaluation phase, the product was tested by expert, one-to-one and small group, and tested on the actual research subject. However, this product was new to the initial design, not to the stage of expert evaluation, one-to-one and small group which is the stage to see the validity and practicality of interactive multimedia developed, while field trials were tested on the actual research subject where the results of the valid and practical prototype was tested in order to see the potential effects on student learning outcomes.

After obtaining valid and practical prototype, then test field test to see the potential effect on learning result was done. This trial was conducted towards the students of 4th grade of SD Sabbihisma and SD N 20 Kurao Padang. The learning result of the 4th grade students of SDN 20 Kurao Padang is described in Table 1.

| Score Interval (x) | Percentage | Predicate |
|-------------------|------------|-----------|
| 80 ≤ x ≤ 100      | 30%        | Excellent |
| 66 ≤ x < 80       | 42%        | Good      |
| 56 ≤ x < 66       | 16%        | Fair      |
| 40 ≤ x < 56       | 12%        | Poor      |
| 0 ≤ x < 40        | 0%         | Failed    |

In the test of final prototype, there was no longer a student whose learning results fall into failed category. The percentage of students who can pass the examination was 72% of the students in the material of solid figure which the learning activities used the developed interactive multimedia in good and excellent category.

4. Conclusion

The prototype of IT-based learning media that developed has potential effects such as: the students could answer similar questions to the sample problems in IT-based learning media, and the test results also shows that the prototype of IT-based learning media that developed could bring the students learning results in good and excellent category. Finally, the use of CS6 program is promising to help the students learning plane and solid figure in mathematics learning. Based on the results of the research and the conclusion above, it can be suggested as follows: (1) Teacher needs to use IT-based learning media not only in conventional learning but also in cooperative learning. It is necessary to develop IT-based learning media not only on solid figure material but also on the other topics. (2) Students could use IT-based learning media in learning both in classroom and at home, so that their skill improved.
References

[1] Leow F T and Neo M 2014 Interactive multimedia learning: Innovating classroom education in a Malaysian university Turkish Online J. Educ. Technol. 13 99–110

[2] Sholikhah M, H D A and Yusuf M 2017 Interactive Multimedia to Enhance Early Reading Skill on Children with Light Mental Retardation at 5th Grader SLB Autis Mitra Ananda Karanganyar Indonesia in Academic Year 2016/2017 Eur. J. Spec. Educ. Res. 2 1–13

[3] Maričić S M and Stamatović J D 2017 The Effect of Preschool Mathematics Education in Development of Geometry Concepts in Children EURASIA J. Math. Sci. Technol. Educ. 13 6175–87

[4] Özdemir B G 2017 Mathematical Practices in a Learning Environment Designed By Realistic Mathematics Education: Teaching Experiment About Cone and Pyramid Eur. J. Edu. Stud. 3 405–31

[5] Uttal D H, Scudder K V. and DeLoache J S 1997 Manipulatives as symbols: A new perspective on the use of concrete objects to teach mathematics J. Appl. Dev. Psychol. 18 37–54

[6] Hidayah I, Pujiastuti E and Chrisna J E 2017 Teacher’s Stimulus Helps Students Achieve Mathematics Reasoning and Problem Solving Competences J. Phys. Conf. Ser 824

[7] Ojose B 2008 Applying Piaget’s Theory of Cognitive Development to Mathematics Instruction Math. Educ. 18 26–30

[8] Collett P, Elizabeth P, Steyn C and Elizabeth P 2017 Using African Designs in Virtual Manipulatives for Geometrical Concept Development Bridges 2017 Conference Proceedings pp 455–8

[9] Durmus S and Karakirik E 2006 Virtual Manipulatives in Mathematics Education - A Theoretical Framework Turkish Online J. Educ. Technol. 5 117–24

[10] Ekici D I 2017 The Use of Edmodo in Creating an Online Learning Community of Practice for Learning to Teach Science Malaysian Online J. Educ. Sci. 5 91–106

[11] Chinapah V and Odero J O 2016 Towards Inclusive, Quality ICT-Based Learning for Rural Transformation on Education for Rural Transformation (ERT ) 2016 J. Educ. Res. 5 107–25

[12] Aldoobie N 2015 ADDIE Model Am. Int. J. Contemp. Res. 5

[13] Chan H, Tsai P and Huang T-Y 2006 Web-based Learning in a Geometry Course Educ. Technol. Soc. 9 133–40

[14] Prahmana R C I and Kusumah Y S 2016 The hypothetical learning trajectory on research in mathematics education using research-based learning Pedagogika 123 42

[15] Sundayana R, Herman T, Dahlan J A, and Prahmana R C I 2017 Using ASSURE learning design to develop students’ mathematical communication ability World Transactions on Engineering and Technology Education 15 245

[16] Tanujaya B, Prahmana R C I, and Mumu J 2017 Mathematics instruction, problems, challenges, and opportunities: A case study in Manokwari regency, Indonesia World Transactions on Engineering and Technology Education 15 287

[17] Prahmana R C I, Kusumah Y S, and Darhim 2017 Didactic trajectory of research in mathematics education using research-based learning J. Phys.: Conf. Ser. 893 012001