# Decision making of the Winner of the National Student Creativi-ty Program in Designing ICT-based Learning Media

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# Decision making of the Winner of the National Student Creativity Program in Designing ICT-based Learning Media

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***Abstract*** **– This case study investigated the decision making process of the winners of the national competition for student creativity programs in designing ICT-based mathematics learning media. The results are revealed based on the decision-making stages: (1) generating ideas, subject designed ICT-based learning media by combining student worksheets with GeoGebra, (2) clarifying ideas, subject consider the systematics design of ICT-based learning media based on the condition of students and student learning outcomes, (3) assessing the fairness of ideas, subject believed that the validity, practicality and effectiveness aspects of ICT-based learning media designed were appropriate to attract students interest and motivation.**

***Keywords*** **– Decision making, Prospective mathematics teacher student, ICT, Learning Media, GeoGebra.**

## 1. Introduction

In the current era of 5.0 society, information and communication technology (ICT) in the world will always dynamically develop. Along with the development of the ICT, Indonesia always strives to improve the quality of learning, one of which is the quality of mathematics learning.

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The improvement of the quality of mathematics learning should be in line with the demands of the latest curriculum, the revised 2013 curriculum 2018. The improvement of the curriculum stipulates that all 3 aspects of student competence, knowledge, skills and attitudes, must be fulfilled. The development of the mathematics curriculum also emphasized the skill of using ICT tools to implement technical calculations (computation) and presentation in the form of images and graphics.

ICT has proven to play an important role in learning. Many education units in Indonesia have tried to improve classrooms' ICT facilities such as the availability of computers and internet connections. Apart from being the object of study, ICT acts as a learning tool [1]. Software programs as part of ICT are very useful for students. The software is designed for various purposes, including: creating graphics, managing data, and completing calculations. Learning by using technology helps students to develop an understanding of mathematical practices and methods of teaching mathematics for teachers [2].

ICT-based learning has become a demand in building a more effective approach to student learning. ICT applications produce simple but positive effects on mathematical performance compared to traditional methods [3]. Assisted learning or ICT-based learning is very important to be applied in learning mathematical concepts. Seo & Woo [4] state that computer-assisted learning programs developed specifically for students' mathematical skills can be effective tools to help students learn to easily master certain mathematical concepts.

Some studies also confirm the effectiveness in teaching mathematics and science involving the use of computer programs [5],[6],[7]. Computer-aided learning is significantly more effective than traditional mathematics teaching on student creativity, elaboration, and originality [5]. Computer-based science learning can significantly improve student achievement and problem solving

skills [6]. The use of computers as computational tools in learning mathematics in elementary schools can increase student motivation, collaboration and discussion based on students' own exploration experiences [7].

Various computer programs have been developed and can be used in learning mathematics, such as GeoGebra, Geometer's Sketchpad and Mathematica. GeoGebra is a computer program (software) for mathematics, designed specifically for learning geometry and algebra [8]. GeoGebra is a free online software application for geometry, algebra, trigonometry and calculus study at different grade and teaching levels [9],[10]. It allows students to check whether each step in the process of completing a task has been correctly done. Student learning achievements are better at checking functions and drawing graphics by using GeoGebra [11]. GeoGebra is also software that can quickly, accurately, and efficiently visualize mathematical objects.

The development of learning media that utilizes GeoGebra has been implemented by one of the prospective mathematics teachers in Indonesia. The results of this development have won the national level competition at the Student Creativity Program organized by the Indonesian Ministry of Higher Education. The developed learning media are a combination of student worksheets and GeoGebra. Learning media was developed in one of the vocational high schools in East Java Indonesia where the majority of students had difficulty in understanding the concepts of equation and inequalities of absolute values. From this situation, the student activity sheet with the help of GeoGebra was designed by prospective Mathematics teachers to facilitate better understanding of equation and inequalities concept of absolute values.

Students of Mathematics teaching have succeeded in designing media that combines activity sheets and GeoGebra for students who are new to GeoGebra. The results of this development also inform that the designed media provides a positive response for students and is effective in improving student learning outcomes. In contrast to other researchers who claimed that GeoGebra is only used as tool to solve mathematical problems [10], [11], this project put more emphasis on visualizing mathematical concepts. Realizing that the graph of absolute value equations is different from the usual equation graph, students are facilitated to understand the concepts of equations and inequality of absolute value through GeoGebra visualization.

The instructional media that has been designed certainly provides inspiration for prospective Mathematics teachers specifically and other Mathematics teachers in general. Given that there are many obstacles experienced by teachers in using mathematical software, one of them is GeoGebra [12], as well as the lack of teachers and teacher candidates especially in Indonesia who use GeoGebra to facilitate students' understanding in mathematical concepts. The development of similar media can be used as an example by teachers and prospective teachers to improve the effectiveness of mathematics learning especially in the material of equation and inequalities of absolute value. To find out how prospective Mathematics teacher design this combination of students' worksheets and GeoGebra as learning media, it is necessary to know the decision-making process throughout this project.

Decision making is an essential activity in the learning process [13]. It is a mental or cognitive process that leads to the selection of action among several available alternatives [14]. Decision making of a teacher and prospective teacher is important to be analyzed in order to understand the thinking process [15]. In making a decision, someone does a thought process that starts from generating ideas, clarifying ideas and evaluating the reasonableness of ideas [16]. Thus, this study describes how decision-making of prospective Mathematics teacher as the winner of the national competition for student creativity programs in designing ICT-based learning media that combine student worksheets and GeoGebra are made.

## 2. Methods

This case study uses a qualitative approach similar to the one applied by the national Olympic winner students [17]. The researcher chose the research subject of a prospective mathematics teacher student who had won a national competition for student creativity programs organized by the Indonesian Ministry of Higher Education. The subject of this study was a 23 years old, 8th semester male student, who had participated in a field experience program and produced learning media that combined students' worksheets with GeoGebra. The results of the development of learning media then succeeded in winning the national competition for student creativity programs. The data of this study were obtained from learning media that had been designed by the student and also through interviews. The procedure of this study includes: (1) preparation, researchers examine the theory of ICT-based learning especially GeoGebra and decision making, (2) implementation, researchers determine the subject of research, then examine the design of ICT-based learning media that has been developed by the subject and conducted interviews about the decision making carried out in designing learning media, (3) analysis, researchers conduct data analysis based on the stages of decision making. The decision-making stages used are as follows[16].

*Table 1. The Indicators and Interview Guidelines of Decision making Process in Designing the Learning Media*

| Decision Making Process Stages |
|---|
| a. Generating idea |
| 1) Create ideas as basic to design ICT Media |
| a) What were you thinking when you designed the ICT-based media to teach equation and inequality of absolute value concept?<br>b) What was the main reason to decide the design of ICT-based media in teaching equation and inequality of absolute value concept?<br>c) What are the difficulties that you think you might face when you designed the ICT-based media for teaching equation and inequality of absolute value concept? |
| 2) Explaining the idea in designing the ICT-based media |
| a) In designing the ICT-based media to teach equation and in equality of absolute value concept, what methods or strategy you want to use to present the media?<br>b) Explain the systematical design of this ICT-based media in teaching equation and inequality of absolute value concept? |
| b. Clarifying idea |
| 1) Comparing and choosing ideas in designing the ICT-based media |
| Is there any specific mathematical method or system that can be used to design the ICT-based media for teaching equation and inequality on absolute value concept? |
| 2) Set aside the irrelevant ideas in designing ICT-based media |
| If there are many ideas and systems in designing ICT-based media, how do you decide which idea is the most suitable one? |
| c. Assessing the fairness of ideas |
| Evaluates ideas presented in designing ICT-based media |
| a) Are you sure that designing ICT-based media can improve students understanding in equation and inequality of absolute value concept?<br>b) What sources that you used to design the ICT-based media for teaching equation and inequality in absolute value concept?<br>c) What strategy did you use to evaluate the design of ICT-based media in teaching equation and inequality in absolute value concept? |

Analysis of decision making is based on interview indicators and guidelines that have been developed by researchers based on Table 1. Analysis was carried out through data reduction steps, data presentation and conclusions.

## 3. Results and Discussion

The design of ICT-based learning media developed by the subject is a learning media that combines student worksheets with GeoGebra. The subject designed learning media that begin by understanding students about the equation and inequalities of absolute values of one variable visually through GeoGebra. The subject systematically directed students to understand and solve equations and inequalities of absolute values through the steps seen in the design of learning media in Figure 1. and Figure 2.

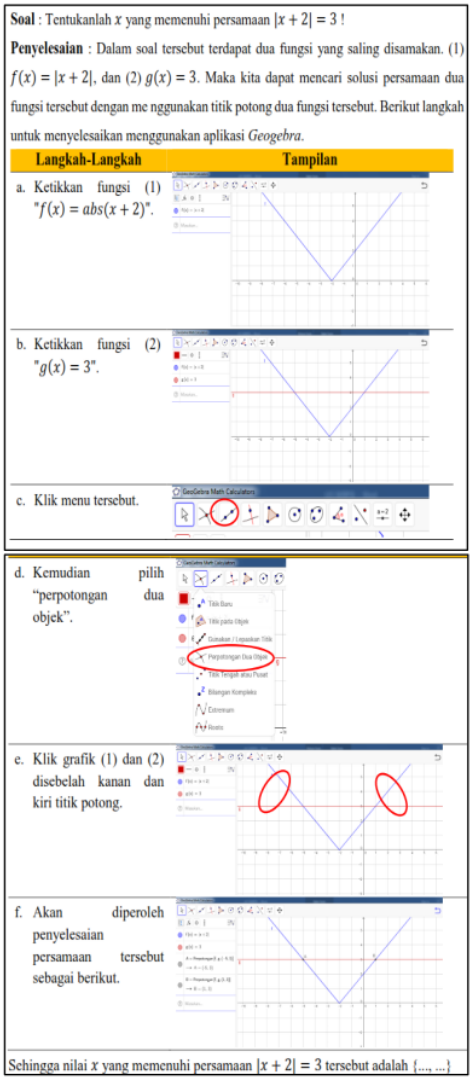


*Figure 1. Students' worksheets combined with GeoGebra in the equation of absolute value topic*

In Figure 1., subject designed student worksheets to solve the absolute value equations that begin by giving a question: "Determine $x$ which satisfies the equation $|x+2|=3$". In the subject design, the problem is solved using GeoGebra by defining two functions that are equated, namely $f(x)=|x+2|$ then $g(x)=3$. Then it is solved as in Figure 1.

Step a. Type function (1) "$f(x)=abs(x+2)$"
Step b. Type function (1) "$g(x)=3$"
Step c. Click the menu to intersect the line
Step d. Select the intersection of two objects
Step e. Click graph (1) and (2) to the right and left of the intersection Step f. Given solution set = {-5,1}.

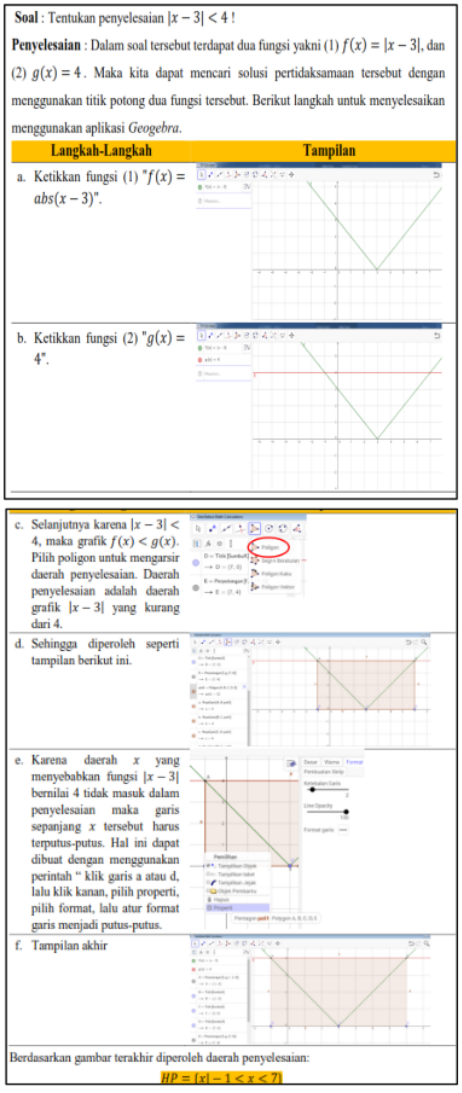


*Figure 2. Students' worksheets combined with GeoGebra in inequality of absolute value topic*

In Figure 2., the subject then designs the student worksheet to solve the absolute value inequality that begins by giving the question: "Determine the solution of the inequality $|x-3|<4$". In the subject design, the problem is solved using GeoGebra by defining two functions, namely $f(x)=|x-3|$ then $g(x)=4$. Then it is solved as in Figure 2.

Step a. Type function (1) "$f(x)=abs(x-3)$"
Step b. Type function (1) "$g(x)=4$"
Step c. Click polygon to shade the solution area
Step d. The solution area is the graph $|x-3|$ less than 4
Step e. Because of the area that causes the function $|x-3|$ value 4 is not included in the solution, then the line $x=7$ then $x=-1$ must be dotted line. This can be created using the command click line $x=7$ or $x=-1$, then right-click select property, select format, then set the line format to be dotted line.
Step f. Given solution set = $\{x|-1<x<7\}$

The decision-making process in designing ICT-based learning media that combines students' worksheets and GeoGebra is done by subjects with the following stages.

### *Generating Ideas*

In generating ideas in designing ICT-based learning media to teach equations and inequalities of absolute values, subjects considered facilitating students' understanding about the concept of absolute value. The subject presented a method of solving equations and inequalities of absolute values that can be easily understood by vocational students. The subject considered some aspects such as the conditions of today's students, facilities or infrastructure available in schools, and current technological advances in designing the idea. The subject also stated that GeoGebra is a mathematics learning application that can be accessed in the play store. Subject also considered the difficulties experienced by students in learning the equation and inequalities of absolute values. The subject stated that "*most students have problems in terms of geometrical representation and algebraic calculating abilities, so I try to present equation and inequalities materials by combining geometry and algebra*". The method used by the subject in designing learning media that combines student worksheets and GeoGebra is discovery guided. The subject stated that "*through the learning media that I designed, I guided students to find the solution of equations and inequalities of absolute value*". Learning media designed in the form of worksheets connected with GeoGebra so students can learn independently and meaningfully through visualization. The subject designed the student worksheet by presenting the

concept and completion through systematic steps between the algebraic forms which were equipped with the operation method in GeoGebra. The idea that was built states that one of the requirements needed by undergraduate programs based on the Indonesian national qualification framework is that prospective students can apply their expertise and utilize science and technology in their fields in problem solving and being able to adapt to the situation at hand [18]. This is also related to divergent thinking of the subject which aims to produce the biggest idea or alternative to overcome existing problems or design a new product, which then generates the subject's convergent thinking to analyze various solutions and choose the best [19].

***Clarifying Ideas***

Subjects compiled learning media in the form of student worksheets combined with GeoGebra on equation and inequalities of absolute value materials. The systematics of the designed learning media that has been chosen by the subject is based on the condition of the students, facilities and infrastructure, and the low student learning outcomes on the equation and inequalities of absolute value materials. The subject stated that "*students have never used GeoGebra in previous learning, so this is a challenge for me to design learning media connected with GeoGebra*". Facilities and infrastructure available in schools support the implementation of learning media designed by the subject. The low student learning outcomes in the equality and inequality of absolute value materials is caused by students' lack of understanding of the concepts. The subject reinforced the idea by stating that "*I designed learning media to help students to understand the equation and inequalities of absolute value materials through visualization on students' worksheets connected to GeoGebra*". The visualization meant by the subject here is a representation of the graph of the function of absolute value. Through the graphical representation displayed by GeoGebra, students can easily understand the symbol of the function of absolute values and graphical forms as stated by [20],[21],[22]. Systematics in the design of ICT-based learning media was made step by step so that students well understand the concepts and procedures of solution. Therefore, the subject mostly provided a descriptive explanation to give instruction for students during the application of this media [23]. Teachers and teacher candidate are mostly involved in new practice exercises by reviewing potential problems and their predictions of student reactions [24]. This happens sequentially in a series of repetitive designs where an idea is developed.

***Assessing Fairness of Ideas***

When assessing the fairness of ideas, subjects are convinced that the design of ICT-based learning media that combines student worksheets and GeoGebra can help students to better understand the material of equation and inequality of absolute value. The validity, practicality and effectiveness aspects of ICT-based learning media with a combination of student worksheets and GeoGebra are feasible to be used as a reference for learning strategies that can attract student's interest and motivation as the progress of the new era. In addition, there are several sources that the subject used to assess the reasonableness of the idea. The subject stated "*research articles on the application of learning with GeoGebra, and the effect of applying GeoGebra learning on this material*". The subject's belief in the developed media was also supported by him winning the student creativity program competition at the national level. This is in line with [15], [25], that the beliefs possessed by a teacher and prospective teachers are factors that influence their decision making. This belief is also in line with prospective teachers who state that language, screen clarity and the ease of use of detailed manuals on GeoGebra are the most important aspects of utilizing dynamic geometry software [26].

## 4. Conclusion

Students of prospective mathematics teacher as the winners of the student creativity program competition at the national level, made a decision-making process in designing ICT-based learning media. In the stage of generating ideas, the subject designed ICT-based learning media by combining student worksheets with GeoGebra to facilitate students' understanding of equations and inequalities of absolute values concept. In the stage of clarifying idea, subjects consider the systematic design of ICT-based learning media based on the condition of students, school facilities, and lack of student learning outcomes on the equality and inequalities of absolute value material during the clarifying ideas stage. While at the stage of assessing the fairness of ideas, the subject believed that the validity, practicality and effectiveness aspects of ICT-based learning media that has been designed were appropriate to attract students' interest and motivation according to the progress of the times. Decision making made by prospective teacher can provide inspiration and examples for other prospective mathematics teachers in making decisions in designing ICT-based learning media.

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