Computer-assisted guided discovery learning of algebra

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Abstract. This article describes a study aimed to identify students' exploring ability of quadratic equations when using the computer in the guided discovery learning. It was a case study that focuses on algebra learning in the first year of pre-service mathematics teacher. Data collected through test and interview. The data analysis found that all students be able to discover that the graph of quadratic equations is a parabola. Students from the high and medium ability were able to explore relations between the change of the leading coefficient of quadratic equations and its graph. They were able to see that some quadratic equations do not have real roots and that this characteristic corresponds to the fact that their graphs do not cross the x-axis. Whereas the low ability students show that they have problem in using computer. They lacked understanding of the relation between quadratic equations and its graph. They are not able to explore the leading coefficient of quadratic equations.

1. Introduction

High school students are expected to have competencies in constructing and sketching graph of quadratic functions from real-word contexts. They are also hoped to be able to explore the characteristics of the graph of the quadratic functions. The competencies should have been owned by high school students from grade 10 so that students continue to pursue to university no difficulty in understanding the problems associated with quadratic equation. Nevertheless, there are always obstacles encountered in learning activities in the first year on the study program of mathematics education in Khairun University. Problems faced were the low mathematical ability of students of pre-service mathematics teacher in North Maluku. One of the problems of is the low ability of algebra especially related to quadratic equations.

Using of multi-method or multi-strategy and multimedia or technology are the demands of the curriculum that must be used by teachers in learning activities both school and university level. The use of strategies/methods and appropriate technologies are expected to give solutions the problems that arise in the world of education because if we can combine computers with learning, especially in constructive learning approach, then the learning activities will be more effective than traditional learning [1]. One of the teaching models that can be used to improve the quality of learning processes and outcomes is the learning of mathematics through the application of guided discovery methods. Discovery learning is one way to convey the ideas with the process of discover, in this process the students try to discover the concepts from a series of activities. The activities in the discovery learning process is an activity in critical thinking and a learning process allows students to discover for themselves through a series of concrete experiences. The development of technology at this time has brought changes in the field of education [2]. There is currently a variety of widely available software that allows teachers to get it and use them in learning activities. Various studies have shown that the
use of computers in mathematics learning activities has improved student learning outcomes. In addition to improving students' mathematics learning achievement, learning with computers in particular can also increase the positive attitude of students towards mathematics [3] and improve the mathematical achievement of students [4]. In addition, the mathematical software also allows students to do things that may not be found or do if they were using paper and pencil in constructing geometric objects [5].

Another reason to combine computer and guided discovery learning in learning of quadratic equation is due to the advantages of the method. The advantage of guided discovery is students can participate actively in the learning process, supports the ability of problem solving of students, provide a vehicle for interaction among students and students with teachers, material learned can reach the level of ability which is high and longer memory because students are involved in the process discover it. Computers also have many advantages. One is the computer as a medium that can be used to enhance the learning experience in order to be more concrete. An algebraic form of the quadratic equation can be shown that a more concrete form geometry representation.

2. Method

This research is a case study. Six students selected based on the results of a pre-test. Selected students were classified based on low, medium, and high levels their ability. Selection of students also based on the gender of each different level of ability. The sixth of these students are taught computer-assisted guided discovery learning. During the learning activities, the researcher explores the learning activities and students' ability in exploring the properties of quadratic equation. Students learn by using students worksheet prepared. Worksheet consists of several tasks that must be completed by the students. Researchers conduct explorations with open interviews to determine the problems faced by the students in doing the task.

3. Results and Discussions

Computer-aided guided discovery learning of this research is a form of computer integration into guided discovery learning. Computers are used as a tool for problem solving presented in guided discovery learning by conducting exploration and inquiry activities to produce a solution of problem solving.

There are six tasks which have to be completed by students in this learning activity. Characteristics from the first two tasks are the quadratic equation which has two roots. The second two tests are that only have a root and the third group is questions that do not have a real solution. The first step in the learning process is that students have to represent algebraic form of quadratic equation in graph of quadratic equation with computer. The use of computers in this activity aims for more effective learning activities because the discovery of computer-assisted learning would be more effective than traditional learning [6]. Furthermore, students are instructed to conduct an investigation and record the characters of each of the quadratic equations that have been constructed. Then the students were instructed to look for relationships between graphs of quadratic equations and discriminant value that has been obtained.

The first two sets of questions are quadratic equations that have two roots. Two tasks have different in the coefficient of $x^2$ and $x$ and constants. Both of question are $y = 2x^2 + x - 6$ and $y = -2x^2 - x + 6$. Both are clearly different and this can be observed by students with ease. If the quadratic equation shown geometric shapes with a computer, it will look as follows.
All students can easily provide a record of the two graph of the quadratic equation given. Students can observe that the two equations intersect the x-axes and y-axes. The first equation opens ‘up’ and the second equation opens ‘down’.

The third and fourth tasks are questions that have only one real solution. Both of the equation are $y = 4x^2 - 16x + 16$ and $y = -4x^2 + 16x - 16$. The geometric representation of the problem is shown in Figure 2. Students can observe that the two graphs of the quadratic equations in question simply intersect one point on the x-axis. One is open up and the other is open down.

The fifth and sixth tasks are question that does not have a real solution. Both of the equations are $y = 3x^2 + 2x + 2$ and $y = -3x^2 - 2x - 2$. The geometric representation of the questions is shown in Figure 3. Students can observe that the two graphs of the quadratic equation are simply intersecting the x-axis. One is open up and the other is open down.
Based on the results of the work of students who have been given that students are able to
determine the all discriminant of the quadratic equation, they are able to explain why the graph of a
quadratic equation is intersect and not intersect the x-axis. They connect with the discriminant value of
each equation. However, it is a new experience of students that the discriminant value is has relation
with geometric representation of the quadratic equation.

The students who are not able to determine the value of the discriminant of the quadratic equation
given, they generally are not able to see the relationship between quadratic equations and its graph.
They just are able to show an equation intersects or not intersects the x-axis, the equation open up and
down, and only estimate that it caused of the leading coefficient is positive. They were unable to
explain of relation between the value of the discriminant and graph of quadratic equation.

Students who have been able to solve the quadratic equation and be able to determine the
relationship between the intersections of the equation on the x-axis with the value of its discriminant
then instructed to solve the quadratic equations which have higher leading coefficients. One of them is
the equation $y = 2x^2 + x - 6$. Students have difficulties to solve the form on this question. Therefore,
they are then ordered to skects the equation and determine of discriminant value of it quadratic
equation. The graph shows that the graph intersects the x-axis at two different points. This is reassured
by the discriminant value of the obtained equation which is more than 0. In this case, it shows that the
student has inadequate skills in solving this type of problem.

Students who are not able to see the relationship between the graph and the discriminant value
required to explain the definition of quadratic equations. They did not understand the definition of
quadratic equations and are not able to determine the coefficient of each variable. Here it is seen that
students' understanding of the quadratic equation is still very low. The next question finds out whether
the cause of the student is unable to explain the notion of quadratic equations. They were asked about
the difference of quadratic equations with linear equations. Then they were asked about the meaning
of the equation. The questions asked were not well explained by the students.

There were no significant difference between males and female students both their skills and ability
to use the computer and found a link between the solutions of quadratic equations with discriminant
value of each quadratic equation. This was consistent with several studies that conclude that ability of
male and female alike when they use guided discovery learning in mathematics [7]. In general,
students can follow the learning activities well. Students who experience difficult mathematical
concepts can also accept with a high positive attitude. This is be caused the discovery learning with
computer-aided design guided discovery provides aimed measures and provide scaffolding students'
own discovery process [8].
4. Conclusion
The advantages of computer-assisted guided discovery learning is the students learn how to learn, learning to respect themselves, self-motivate, minimize or avoid memorization, and students are responsible for their own learning. On the other hand, learning with computers increase students' attitudes toward mathematics [9]. Combing guided discovery learning with computers is the good solution in solving problems faced by students. Attitudes of students taught with this combination show positive trend where students enthusiastically participate in the learning activities.

Computer-assisted guided discovery learning help students in exploring characteristics and relation of discriminant of the quadratic equation and its geometric representation. Students which came from high level ability were able to determine the relationship between the intersections of the equation on the x-axis with the value of its discriminant. On the other hand, students from low and medium ability are not able to see the relationship between the graph and the discriminant value required to explain the definition of quadratic equations. They did not understand the definition of quadratic equations and are not able to determine the coefficient of each variable.

One of the disadvantages of computer-assisted guided discovery is about time. However, with computer-assisted guided student worksheet, it is decrease the problem in the learning process. Because the constructive steps in the student worksheet has encouraged students to focus on the tasks and lead to the learning objectives appropriately. To be successful, teachers have to use consistently computer-assisted guided discovery learning for all materials [10] and the training and knowledge of teachers who use computers in learning were going to provide benefits for students when learning to use computers in the classroom [11]. Therefore, a teacher is required to willing spend time in developing learning material.

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