Development of Geometry Analysis Using Geogebra Scripting in terms of Student Cognitive Capabilities

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Abstract. Geometry is a part of mathematics related to points, lines, planes, flat buildings, and building spaces. And their thought processes must be discussed by students and mastered for geometry analysis. Students must have good analytical skills dealing with geometric questions based on cognitive abilities, namely understanding, connection, communication, reasoning, critical and creative, each of which has indicators as references using the Geogebra help software by Geogebra Script. The method used is a learning development model, and before using ICT media from 41 students, 85.36% participation in mastering vectors and 78.05% not mastering transformation geometry, and after using the inability of media to connect vectors and convert vectors to 48, 78% and 41.47%. And there was a significant increase before and after using media supported by GeoGebra scripts, namely the average grade from 29.88 to 58.29. Based on these results because there is an increase in the cognitive abilities of students who use Scripting Geogebra, however, there is a need to consider evaluating especially reasoning ability, problem-solving, and critical because the increase is below 50%.

1. Introduction
Geometry is one of the important topics in developing student thinking processes. By learning geometry, students will learn about geometric shapes and structures and analyze their characteristics and relationships. Such activities can provide a stimulus for developing thought processes, activating creativity, developing problem-solving skills and reasoning and can support other topics in mathematics[1].

Geometry is also very useful for students to build spatial abilities, geometrical reasoning abilities, and strengthen mathematical evidence. Geometry has many roles in the development of student mathematics, providing broad opportunities for students to develop their spatial visualization skills and geometry reasoning to obtain high-level thinking skills[2].

Cognitively, it is necessary to deliberately design geometric learning to create an environment that supports cognitive learning. If students are required to be prepared for a deductive geometry curriculum, it is important for students' thinking to develop at level 2 (informal deduction) [3]. In addition to the cognitive domain, skills to be able to interact in a social atmosphere also need to be developed that will be very useful for future life such as interpersonal communication skills and collaboration skills[4]. Visualization assistance plays an important role in learning geometry. Using data visualization that is displayed can make it easier for researchers to see data that is difficult to see with thought so researchers can observe simulations and computation. Therefore, there is a need for
innovation in learning mathematics by using software that helps visualize geometry. One software that
can help visualize geometry is GeoGebra-Scripting[2].

GeoGebra-Scripting is a free software based on mathematics learning developed by Markus
Hohenwarter from Austria who uses the order of orders, which are executed one by one. GeoGebra
supports two script languages - GGB Script and Javascript. Execution can be triggered by: clicking on
a particular object updating a particular object (when the value or property of the object is changed)
loading the file (in the case of JavaScript) the Javascript Listener. Scripts can be created by creating
commands that consist of GeoGebra commands, such as can be used in the Input Bar. After triggering
the script, each command is executed one by one. Example: a is a slider with integers ranging from 1
to 3 (therefore Addition is equal to 1) type: list1 = {"red", "green", "blue"} in property a, set the script
"On Update" to SetColor (a, Element (list1, a)) by moving the slider, can change the color.

According to Yuliardi [5], a number of studies show that GeoGebra can encourage the process of
discovery and experimentation of students in the classroom. GeoGebra specifically matches geometry
material because (a) Offers features that can transform objects on the screen. (b) It allows users to
draw geometric shapes easily and can measure distances, angles, and width precisely. (c) It provides a
click-drag feature that gives students the opportunity to decipher or construct geometric shapes in
topics that require visibility such as geometric transformations in the rotation sub-section. It is
expected that GeoGebra software users can help the process of visualization which should have a
positive impact on increasing interest in learning to increase student creativity in knowledge of
geometry analysis, according to Rohaerti [6] can improve students' connection skills with
metaphorical thinking [7], can improve punishment ability on Euclid's geometry analysis material [8].

2. Methods
The study was conducted in one class at the Siliwangi IKIP, with a sample of 41 students. The
duration of the study was carried out for 6 months and 16 meetings. The method used is a method of
identifying the learning development that stage, the stage of developing, evaluating and revising stage
[9].

![Chart Model Development Research](image)

Figure 1. Chart Model Development Research

Stage identify, by looking for the difficulties of students in working on the analysis of the geometry
in the form of a written test, the test results are analyzed based on the cognitive abilities of the
students, and make the findings of the difficulties students adjusted to the indicators of cognitive
ability.

Developing phase, the results of these findings to be a reference to make learning to use the media
strategy GeoGebra via scripting.

Phase evaluate, media GeoGebra via scripting delivered to the students to solve the problem of
analytical geometry, the students tried to use, after that, re-examine student mistakes done by
comparing results of students at the time before and after use GeoGebra via scripting.
Phase revise, if there is a weakness of the study media, the findings feed into the difficulties students
who need to be added or subtracted to develop better media.
3. Results and Discussion

3.1 Result
The results of the study, it was found that the students who are learning without using scripting GeoGebra to solve the problem of analytical geometry have an average value of 29.88 with a standard deviation class 12.22 and after using scripting GeoGebra into a class average 58.29 with a standard deviation of 9.93 means in mastery of analytical geometry to an increase in the average value of the class and to value each student after using GeoGebra scripting more evenly distributed than ever before, it can be seen from the standard deviation after learning to use a smaller GeoGebra compare with scripting before.

To see whether the difference in the average value before and after the learning classes using scripting GeoGebra, the data is processed by the normality test. Where significant value to test for normality using the Shapiro-Wilk, significant values obtained for prior use scripting GeoGebra 0.083 and to thereafter is 0.254. Both were higher than 0.05 means that both the data value is normal, and continued with the paired t-test.

Of the paired t-test obtained significant value of 0.000 is less than 0.05, meaning that there are differences in the average value significantly between learning before use scripting with GeoGebra thereafter in line with the opinion of Bernard [10] that the ICT-based media can improve the cognitive abilities of students, where learning better afterward than before. And a significant correlation value of 0.04 <0.05, meaning that there is the influence of GeoGebra scripting before and after use, with a correlation value of 0.44 medium category.

3.2 Discussion
Analysis of geometry applied to the students is the material about relationships of points, lines, and flat fields in three dimensions. The aim of such material are students able to master and develop analytic geometry of the basic knowledge and there are prerequisites that need to be mastered is the control vector and geometry transformation. From the observations based on preliminary observations through a basic test of three-dimensional geometry questions, which of 41 students found that there were 85.36% or 35 students unable to master vectors, whereas vector analysis was the most important factor in solving problems in geometry analysis [11] there were many errors in concept understanding [12] and 78.05% or 32 students were not able to master the geometric transformation seen from the work description analysis results in geometrical time before learning using GeoGebra scripts, but after using, students’ inability decreased to 48.78% or 20 students in vector analysis and 41.47% or 17 students for mastering transformation geometry [13].

Table 1. Students mastery Geometry Analysis Before and After Using Scripting GeoGebra

| cognitive indicator | Before | After |
|---------------------|--------|-------|
| number of Students  | %      | number of Students | %      |
| Knowledge           | 26     | 63.41%         | 32     | 78.04%         |
| Identifying         | 18     | 43.90%         | 24     | 58.53%         |
| characteristics of  |        |                 |        |                 |
| a concept           |        |                 |        |                 |
| Applying the concept| 8      | 19.51%         | 21     | 51.12%         |
| in the algorithm    |        |                 |        |                 |
| Developing the      | 16     | 39.02%         | 27     | 65.85%         |
| requirements        |        |                 |        |                 |
| necessary or        |        |                 |        |                 |
| sufficient condition|        |                 |        |                 |
| of the concept      |        |                 |        |                 |
| Communication       | 23     | 56.09%         | 34     | 82.92%         |
| How to describe the |        |                 |        |                 |
| object              |        |                 |        |                 |
Table 1 illustrates the findings of factors being the difficulty of students while working on analytic geometry problems before and after the use of media. The data is a problem of students who become evaluations for the development of learning media using geometric analysis software with the help of GeoGebra Scripting as an interactive analysis process in terms of students' cognitive abilities after they use and try to implement media. Based on these data, there appears to be an increase in each student's cognitive, where students are more interested in exploring ways to find solutions using the media on communication skills and understanding the similarity of 3-dimensional perspective shapes in 2-dimensional fields in connection ability with each increase 41.46%, but there are some things that need to be evaluated GeoGebra Scripting media based on the cognitive abilities of students who are still below 50%, namely a) reasoning ability with indicators of analysis, verification, and synthesis, but a consideration of an increase in analysis of 26.83%, verification 36.58% and synthesis 29.27%; b) ability to solve problems with indicators planning to solve problems but an increase in ability by 21.95%; c) the ability to think critically with indicators develop meaningfulness through the number of statements, but an increase of 26.83%.

Media were prepared using the software GeoGebra version 4.4 which is software geometry featuring 2-dimensional, where the media will be made in the form of three-dimensional [14], through an analytical process that is associated with the transformation and dilatation in the form of a matrix but should be reconsidered on the content of media so that students do not experience boredom by creating an attractive image results [15]. At the beginning of the work, the students are making the plain language of the knowledge base for a three-dimensional matrix. Added other elements as consideration for media development, namely the analysis of students 'difficulties in doing geometry analysis on the initial test in terms of students' cognitive and observations of the findings of the factors causing student difficulties.
Figure 2. Using Input Geometry Analysis

Figure 2 describes the search for a common line from one point to the field, the first step that must be presented to the student has identified three intersecting points between the field with the axes x, y, and z. Here the students have understood and mastered because there is an element of a line segment that intersects with the field of the axis made of the form of algebraic equations. The second step, identify a point in three dimensions, it is not too difficult for massive, but at the time of the third step of how to determine the symmetrical lines, students experiencing difficulties there are several factors that are met: 1) Students are not the usability of formula across product, 2 ) has not been able to make sense of the equation symmetrical lines, 3) cannot identify the difference equation and the equation of the line. In the third step was found difficulty in identifying the concept of knowledge and understanding ability, Explore data on basic knowledge on communication capabilities, as well as the cross product of evidence helpful to get a vector perpendicular to the results of the vectors lies in the field. And knowledge about the symmetric line equation can be explained on the postulate of Euclid is about perpendicular lines. After the results of the vector associated with a point and get the results from the equation, the fourth step, an evaluation of the workings of the media to prove the truth and inferred to check the truth of the first, the results of these two points form a vector parallel to the vector is sought by calculation, the second the third point is rotated so that the points of the third cut Sumbo fields as if seen a line perpendicular to the point to field or equivalent represents the same or connection capabilities.
Figure 3. apply to the Scripting GeoGebra

Figure 3 describes the conclusions from the media using GeoGebra input to scripting, which can be written in the form of algorithms of mathematical functions form that is easily understood by students. Both students can create mathematical algebra in the form of an image by using the language. Third, students can understand the reason for the results of verification steps is made, which can assist in the analysis of the ideas are built. And fourth, Students are able to identify each of the functions keys or other objects are ordered according to their needs.

Figure 4. Results of Student Work One

Figure 4 describes the work of the students to solve the problem of the distance only between the two fields are parallel, the students were able to present the form of an image of the second equation field, from the writings of a student trying to evaluate errors that match the images GeoGebra, the students were able to identify the position of dots and one point is associated with a vector perpendicular to both fields, and have a grasp of the distance from the sense perpendicular to both fields. In addition, there are disadvantages of current students do GeoGebra scripting, in general, students still rely on the language of the previous program GeoGebra scripting seen from the similarity created by previous students, although students try looking for answers, there is an error in the proof of the point of intersection of the field. But this can be discussed by adding input.

With the input command on the information obtained that there is a need for student input functions to solve the problem so that the results can be verified.

Table 1 also explains the increase in student cognitive abilities after using scripting GeoGebra as a solution in analytic geometry. The highest increase lies in exploring ways and understands the
equivalent representation of the same with an increase of 41.47%, validating and ability to raise and develop of thinking itself the increase of 36.58%, an increase in the ability to apply the concept in the algorithm with an increase of 31.70%.

Figure 5. Results of Students Develop Scripting GeoGebra

Figure 5 illustrates that the students are able to develop analytical geometry based on cognitive ability [8,9] seen their exploration of the questions from the form of a flat surface to form the curved area, can present algebraic function to form an image, can prove to the image of the results of conjecture, can develop from new ideas seen from the way in the form of analysis algorithms.

4. Conclusion
Using GeoGebra scripting significantly improves teaching and learning of analytic geometry. There is an effect of the use of GeoGebra scripting to the results of learning which is proved by test results before and after using Geogebra software media. There is a moderate correlation or relationship. Based on the analysis of student difficulties related to students' cognitive, while working on the test in general, there is an increase in each ability cognitive mainly on the ability of students' understanding, communication, connections [6–8] but it takes a re-evaluation of the GeoGebra scripting on reasoning, problem solving and critical abilities. Other findings when students learn to use Geogebra Scripting, students are more active in exploring more to find, students are able to express themselves in proving the truth through the concept of images.

5. Reference
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