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Developing a Simulation of Transformation Geometry by Using Flash

ABSTRACT: *The development of science and technology stimulates the rise of effort to make use of all facilities in all fields. One of the results is increasing number of computer use in Indonesia. This condition encourages educational practitioners to develop several models of learning media by using computers with purposes of tutorial, exercises, simulations, and games. Meanwhile, learning process which applies some media of simulation provides some benefits as they are realistic, secure, and simple. This simulation will lead students into a visualization of real life condition. Without media, students will usually imagine what they learn. It later exposes them with some problems that influence their abstractions. If a lecturer only explains about Transformation Geometry without using simulation, there is a big opportunity that students will yield misconception or they will only remember it with little understanding. This research aims to develop a valid and practical the Transformation Geometry simulation. The method in this research is a design research from a technology perspective that uses a preliminary stage and evaluation stage. The result presented the simulation of the definition of reflection, rotation, rotation half-round, and translations that have been made are in accordance with the curriculum and the existing concepts. Try-out result shows that the simulation can help students find their own concepts of reflection, rotation, rotation half-round, and translation; and sets up students to communicate. The conclusion of this research is that the result of simulation design that has been created has to be valid and practical.*
KEY WORDS*: Development of Science and Technology; Computer Use; Transformation Geometry; Learning Process; Understanding of Concepts.*

INTRODUCTION

The development of science and technology stimulates the rise of effort to make use of all facilities in all fields. One of the results is increasing number of computer use in Indonesia. In accordance with the data of IDC (International Data Corporation), it is revealed that total number of laptop sold in semester one of 2010 reached 2.18 million units. There is an increase at 32.46% compared with the total number of computers sold in semester one of 2009, which was 1.6 million units. This condition encourages educational practitioners to develop several models of learning media using computers with purposes of tutorial, exercises, simulations, and games (Hu *et al*., 2010; and Spector, 2013).

According to Molenda Heinich & Smaldino Russell (1996), learning process which applies some media of simulation provides

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some benefits, as they are realistic, secure, and simple (Heinich & Russell, 1996:332). This simulation will lead students into a visualization of real life condition. Without media, students will usually imagine what they learn. It later exposes them with some problems that influence their abstractions. If a lecturer only explains about Transformation Geometry without using simulation, there is a big opportunity that students will yield misconception or they will only remember it with little understanding (Jonker & Galen, 2004).

Simulation applying traditional visual aids always addresses problems in terms of production process. They will require some materials of real objects that are considered impractical and uncomfortable. It causes lecturers' mind-set in which they come to a conclusion that computers can accommodate their functions. A Transformation Geometry simulation using computer animation is considered more flexible and comfortable compared with traditional simulation model (Thalmann & Thalmann, 1990 and 2000).

A computer simulation offers learning opportunities in a dynamic, interactive, and private way (Arsyad, 2010:96). A simulation is a form of computer use employing the function of CAI (Computer Assisted Instruction). In this context, Y.P. Xin & A.K. Jitendra (1999) reported that CAI is the most effective method, as substitutions for teachers or lecturers in learning process (Xin & Jitendra, 1999). Meanwhile, G. Fitzgerald, L. Fick & R. Milich (1986) and C.M. Fletcher-Flinn & B. Gravatt (1995) also stated that CAI was more effective than any traditional instructional equipment to accommodate broader competence in Mathematics, Science, Arts, Reading, and Writing (Fitzgerald, Fick & Milich, 1986; and Fletcher-Flinn & Gravatt, 1995).

The discussion of Transformation Geometry includes reflection, rotation, translation, and dilatation (Rasmedi, 2009). Transformation Geometry understanding can use visual aids that enable students to comprehend the concept of Transformation Geometry. Therefore, it is necessary to use moving pictures that may assist students in learning the Transformation Geometry.

A software, that can be used to design the Transformation Geometry simulation, is Macromedia Flash 8. This software is used to make animation, either interactive or not interactive (Madcoms, 2004:1). It is the older version of the more popular and recent flash animation maker, Adobe Flash CS6. Macromedia Flash 8 has its own benefit as the installation does not take large space of disk and can be used fluently in computers with hardware specification and operating system equals netbooks. Despite the fact that Macromedia Flash 8 provides animation users with attachment program through action script, flash animation focuses more on the timeline that enables users to learn it in a short time without any knowledge about Algorithm and Programming.

Priyanto Hidayatullah, Aldi Daswanto & Sulistyo Ponco Nugroho (2011) stated that, in general, there are many programs that can be employed to develop animation, such as J2ME (Java 2 Mobile Edition). However, for beginners or novices, this application is not likely chosen as a main option, since it mostly deals with programming. Novices are not used to programming model application (Hidayatullah, Daswanto & Nugroho, 2011).

One characteristic of learning models is that they contain and relay messages or information to receivers or students (Arsyad, 2010:81). According to A.S. Sadiman *et al.* (2007), media is anything that can be used to deliver messages from senders to receivers, so that it can stimulate thought, feeling, attention, and interest of students in a certain way during learning process (Sadiman *et al.*, 2007:7). Molenda Heinich & Smaldino Russell (1996) also stated that media is communication mediator (Heinich & Russell, 1996:8).

A computer simulation offers opportunities to learn in dynamic, interactive, and personal ways. The success of its use can be influenced by basic models, scenario, and teaching layers. Scenario must reflect real life situation. It determines what happens and how it happens, who the characters are, what objects are involved, in what way students take part, and how they deal with the simulation. Basic model is the second factor affecting the success of simulation. Model is a Mathematic formulation or rules that reflects causal relationship (Akker *et al.* eds., 2006b).

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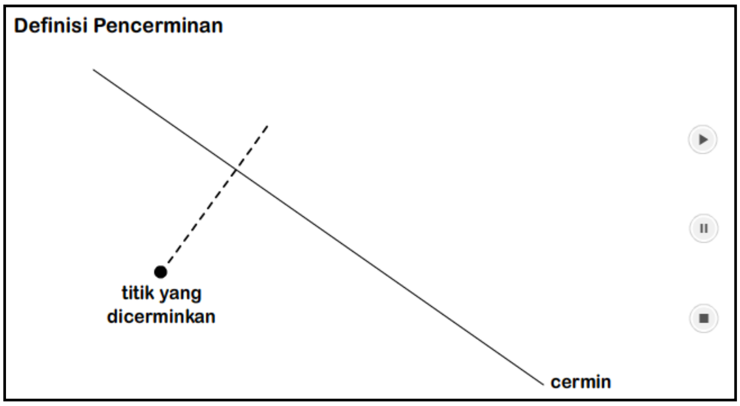
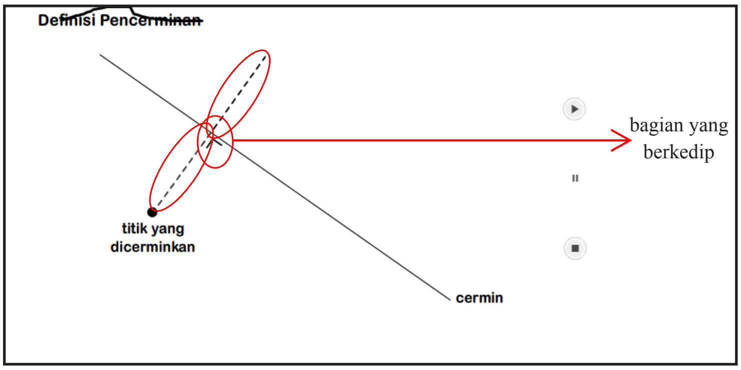
From the explanation above, the researchers intend to construct a Transformation Geometry simulation design that can be used by lecturers and students of Mathematics Department as a media or visual aids to grasp the concept of Transformation Geometry. This research aims at creating Transformation Geometry simulation using flash.



Movement 1



Movement 2

Image 1:
Simulation Display of Reflection Definition

RESEARCH METHOD

The method applied in this research was design research model in the perspective of technology (Akker *et al.*, 2006a; and Reeves, 2006). This research was conducted in two main steps: *preliminary step* or preparation step covering practical problem analysis by the researchers and practitioners; and *evaluation* step in which the researchers designed a solution based on the design and technology innovation principles, interactive cycle of try-out process and practical revision from the given solution, and reflection of the product. It was conducted from October to December 2013 at the Department of Mathematics Education FKIP UMP (Faculty of Education and Teacher Training, Muhammadiyah University of Purwokerto) in Central Java, Indonesia.

RESULT AND DISCUSSION

The design of Transformation Geometry simulation, which was constructed, only focused on defining concepts of each type of transformation, including reflection, rotation, half-round rotation, and translation. At the beginning, these four types of definition were compiled into one file. That file contained navigations directing to each transformation definition simulation.

Considering the function, the researchers decided to separate definition simulations based on the transformation types as stated in the limitation of problem. They were separated with a reason that they could be displayed together, at the same time, and be stored in a smaller size.

Navigation buttons, which are included, are the buttons of play, pause, and stop. Each button possessed their own functions. Play button is used to play the animation from the beginning. If the animation has run to the end of frame, it can function to play the next frame, if it is stopped by pressing pause button. Pause button works to stop the running animation. Stop button is used to stop the animation in the last frame or stop the animation and replay it from the beginning.

In a simulation of reflection definition, the researchers paid attention to the straightness of line cutting made through reflected points and points resulted from reflection with the mirror. The distance of the reflected point to mirror and the distance from reflection result point towards mirror must be equal.

Considering the importance of two elements above, the researchers make animation of reflecting definition that covers those two elements by setting those two to be blinked that they will attract the users. See image 1.

In rotation simulation, the researchers make the design by moving the rotated points into rotation result point, as shown in image 2. There are two main concerns in rotation simulation as: the distance from rotation center point that must be rotated that has to be equal with the distance from the point of rotation center to potation result point; and certain angle resulted from the rotated point, rotation center, and rotation result point.

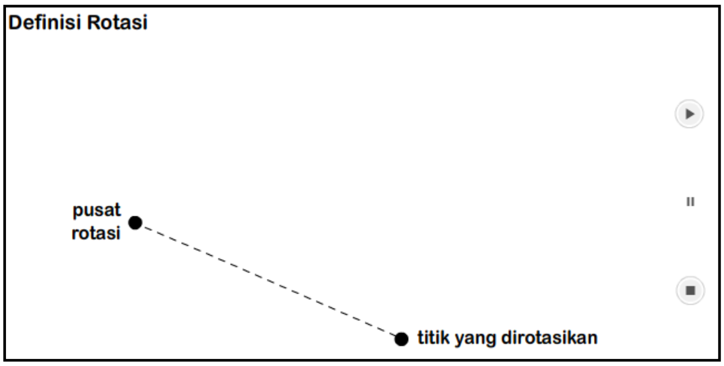
The researchers make those two elements blink, so that users can focus on those two conditions of rotation. It is expected that they will comprehend the concept of rotation without asking. See image 3.

In half-round rotation, the researchers focused on two main concerns for users. Movement direction of the rotation as in half-round rotation, which users may regard the rotation moving clockwise and counter clockwise similar, as shown in image 4. The distance from rotation center to half-round rotated point and the distance from rotation center to half-round rotation result point have to be equal, as shown in image 5.

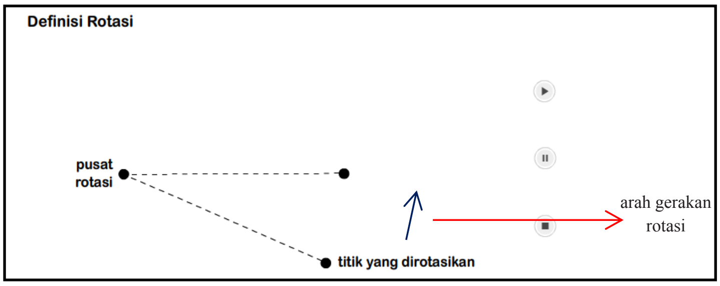
The researchers do not include the size of rotation angle. It is because in the angle of half-round rotation, rotation as the center point between the rotated point, and the result of rotation point can be considered a sufficient condition of half-round rotation.

In translation simulation, the main concern of users is the direction of translation and size of translation vector. See image 6.

Though in calculation, translational results must be done analytically by having separated



Movement 1



Movement 2

Image 2:
Simulation Display of Rotation Simulation

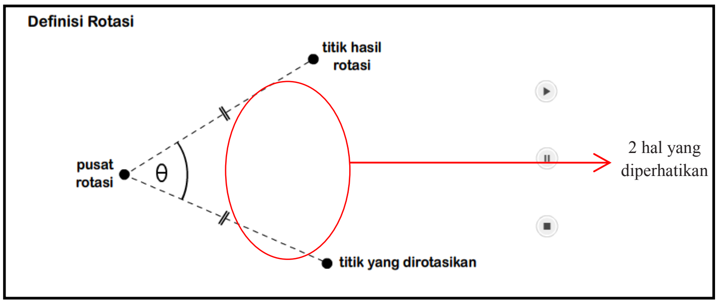


Image 3:
Attention to Rotation

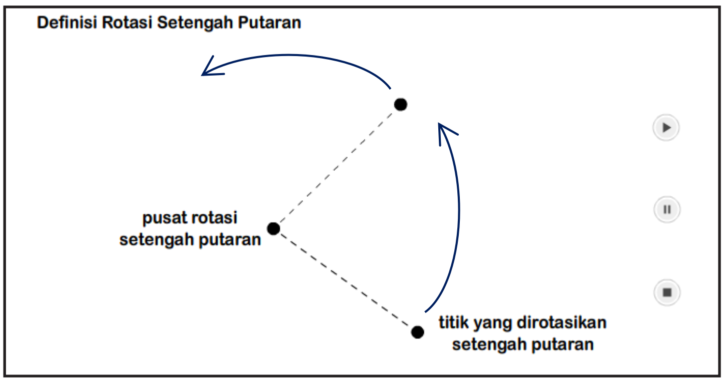


Image 4:
The Direction of Half-Round Rotation

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calculation between basis and ordinate, yet conceptually translational result is gained by following translational vector direction. Therefore, the researchers make movement points of translation results following translation vectors' direction, as shown in image 7.

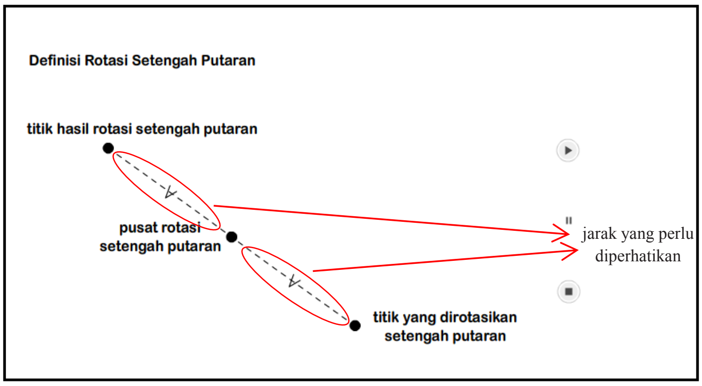

Image 5:
Half-Round Rotation

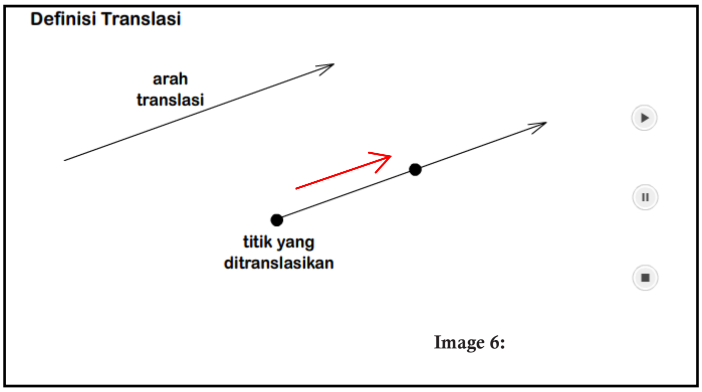

Image 6:
Translation Movement Direction

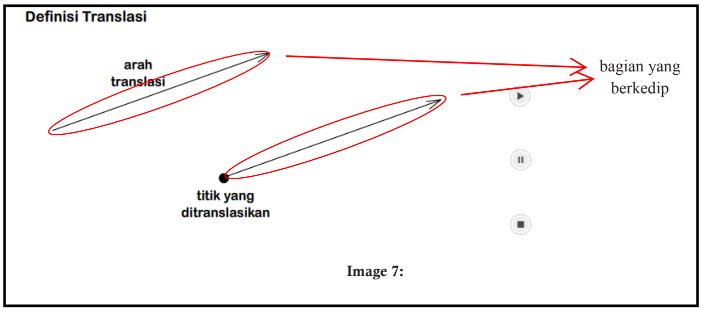

Image 7:
Simulation Display of Translation Definition

Validation results can be explained as follows:

First, in terms of content, validators stated all contents were in line with curriculum of Mathematics Department. Two validators suggested that the coverage of media should have been extended. Yet, the researchers considered to expand the coverage of simulation design in the following research.

Second, validators stated that design results had reflected the indicators of material comprehension. The second validator stated that media was only for students' conceptual comprehension. The third validator suggested that the definition should have been written. This suggestion could not be accepted under consideration that the simulation might lead students to find the concepts with their own language.

Third, validators stated that the design was in accordance with the correct material concept.

Fourth, the first validator stated that the material should have been improved. It was in line the second validator that suggested to add transformation simulation in Cartesian coordinate. This advice was taken into account for the next research. In general, validators considered that the design was appropriate for students' comprehension level.

Fifth, validators agreed that the design could stimulate further development of transformation concept. They stated that this design is suitable to start an introduction of certain concepts.

Sixth, the validators said that the design was constructed in a simple way that it could be easily used by students. The second validator suggested that simulation design would be extended that it required transformation visualization in diagram catechus. This suggestion became an object of consideration in the following research.

Seventh, validator 1 and 3 gave statements in the validation sheet that the design could be easily used without any certain software and any installation.

Eighth, validators said that there was no execution mistake in navigation. They stated

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that all navigation reached its targets.

Ninth, though validators suggested that the colors should have been varied and more attractive, the researchers made no change with a reason that the original colors, black and grey, might make students pay full attention to the movements. Colorful images might obstruct students' concentration towards expected targets to comprehend concepts of each type of transformation.

Tenth, validators tried the design and stated that there was no mistake in the execution of design.

The try-out was conducted with subjects of fourth semester students from Mathematics Education Department FKIP UMP (Faculty of Education and Teacher Training, Muhammadiyah University of Purwokerto) in Central Java, Indonesia, in the academic year of 2012, which planned to have Transformation Geometry in the next semester. The researchers presented the design to subjects after we had asked about transformation, since we believed that students had had learnt about it in Senior High School.

The first student is Izat. He scored A in Plane Analytic of Geometry. The researchers only presented a result of interview related to reflection from the overall recorded interview. Izat knew about reflection since he had studied about it, when he was in Senior High School. It was proven by his ability to determine a reflection result of a certain point, as shown in image 6. He understood about reflection yet he got difficulties to define it with his own language. He only mentioned a condition in reflection (interview with Izat, 28/10/2013).

In fact, there were two conditions that reflection could be formed from a reflected point: reflection line and reflection result point. It was proven from the dialogue between the researchers and Izat, conducted on 28 October 2013, as follows:

The Researchers: "What's the cause? Why is that the result?"

Izat: "Since the mirror is like this, the reflection is reversed" (while moving his hands to result that the researchers asked with a purpose of showing the process).

The Researchers: "What is the condition? What is the condition of reflection?"

Izat: "The distance between the item to the mirror and the mirror to the reflection are equal".

The Researchers: "Besides that?"

Izat: "Biasanya bayangannya jadi terbalik" (the reflection is usually reversed).

The Researchers asked Izat to observe reflection design result.

The Researcher: "Well, from the image (the simulation), what are other conditions of this reflection?"

Izat: "If a line is drawn from the item to mirror, it create an angel of 90 degrees".

The second student is Yoga. He got C for Plane Analytic of Geometry. It made him one of students in low competent category. The researchers only presented the result of interview about rotation from the overall conversation. Yoga stated that he once learnt about rotation in Senior High School. He could answer some questions about determining result of a rotation. He could mention one condition in rotation, which was the distance from the center of rotation to the rotated point should have been equal with the distance from the center of rotation to the rotation result (interview with Yoga, 10/11/2013).

It was proven from the dialogue between the researchers and Yoga, conducted on 10 November 2013, as follows:

The Researchers: "Syarat dari rotasi itu apa?" (What is the condition of rotation?).

Yoga (take a minute thinking): "The distances are equal".

The Researchers: "The distance from what point to where?"

Yoga: "From A (rotated point) to P (rotation center point) and from A' (rotation result point) to P' (while pointing at the points), then it rotates with P as its center".

Yoga could not mention conditions related to rotation angles. He could only explain that rotation was supported by rotation center. Later, the researchers provided an example if a rotation was supported by another rotation, then the result of transformation could be more than one. Therefore, the researchers showed a result design of rotation simulation that it made Yoga able to mention the

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conditions (interview with Yoga, 10/11/2013).

It was proven from the dialogue between the researchers and Yoga, conducted on 10 November 2013, as follows:

> *Yoga: "Angle".*
>
> *The Researchers: "What angle?"*
>
> *Yoga: "Angle resulted from …" (thinking).*
>
> *The Researchers: "A, A', and P".*

The third student is Ani. She scored B in Plane Analytic of Geometry. Ani is in the category of mid competent students. The researchers showed only a result of interview about half-round rotation for the whole interview. Ani seemed to have little understanding about translation. When the researchers asked her to draw a result of translation, she seemed to be reluctant, and at first it seemed that she did not understand about the meaning of translation (interview with Ani, 25/11/2013). It was proven from the dialogue between the researchers and Ani, conducted on 25 November 2013, as follows:

> *The Researchers: "If it is a point, then this point is translated in a vector with this length and direction (while making sketch on paper), where is the result of translation?"*
>
> *Ani: "It could be here or here?" (while pointing at the direction unparalleled with vector direction).*

Ani could sketch her translation result correctly. Yet, when she was asked about transformation conditions that something could be defined as a translation, she could only explain it with her own language. Following is a dialogue between the researchers and Ani, conducted on 25 November 2013:

> *The Researchers: "Why (the result is there)?"*
>
> *Ani: "It is because in translation, we need to find out the length and the direction".*

Later, the researchers showed translation design to students. We, then, asked Ani to find out if this design might stimulate her to express her Mathematic language. Again, following is a dialogue between the researchers and Ani, conducted on 25 November 2013:

> *The Researchers: "Or what can you say about this line with this line?" (the researchers pointed at the translation vector on the design).*
>
> *Ani: (still thinking).*
>
> *The Researchers: "What about the line?" (while pointing the design shown to Ani).*
>
> *Ani: "Parralel".*

The fourth student is Anggit. He is in the category of mid competence students. His score in Geometry Analytic was B. He came from a Vocational School; hence, he learned transformation when he was in Junior High School (interview with Anggit, 5/12/2013).

The researchers take the result of interview with Anggit in relation with half-round rotation. When Anggit was asked to determine the result of half-round rotation, he could determine the result correctly. He mentioned two conditions in which a transformation can be regarded as half round rotation. The first condition was that the distance of rotation center to the rotated point should have been equal with the distance of rotation center to rotation result point. The other condition was that the angle formed by the rotated point, rotation center, and rotation result point was 180 degrees (interview with Anggit, 5/12/2013).

Moreover, Anggit was unable to mention the direction of half-round rotation, whether it was clockwise or counterclockwise. Having observing half-round rotation simulation design, Anggit could mention that the direction of half-round rotation was counter clockwise. It was proven from the dialogue between the researchers and Anggit, conducted on 5 December 2013, as follows:

> *The Researchers: "To what direction does it move".*
>
> *Anggit: "It moves clockwise".*
>
> *The Researchers: "In Mathematics, to what direction does rotation move?"*
>
> *Anggit: (Thinking).*
>
> *After that, half round rotation simulation is shown to Anggit.*
>
> *The Researchers: "In what direction does it move?"*
>
> *Anggit: "It moves clockwise, sir".*
>
> *The Researchers: "See the hand" (while appointing at the watch Anggit is wearing).*

Anggit: (Looking at his own watch) "counter clockwise, pardon me, sir".

Simulation design made by the researchers covered reflection, rotation, half-round rotation, and translation in separated files. It was based on the reason that it would be more practical to use and saved more disc space, due to small size of each file. This design was made by considering conditions of each concept of transformation type. The design was constructed by making a central movement, which should be focused on by users in relations with conditions of each transformation type.

Validators gave many positive statements towards simulation design. A suggestion stating that the material coverage should be extended became the researchers' consideration for the next research, due to insufficient time allotment. Validators agreed that this design could be used as an initial concept to a more complex concept.

Based on try-out result of Transformation Geometry design to some students, it was found out that this design could assist students to construct their own concepts and communicate abstract ideas, which were difficult to explain.

CONCLUSION

Transformation Geometry simulation design, which consists of reflection, rotation, half-round rotation, and translation, is valid and reliable. This design can assist students to construct and strengthen conceptual students' understanding of reflection, rotation, half-round rotation, and translation as well as helping them to communicate this concept.

The advice of this research is that the lecturer should use media simulation, if it is related to Geometry material in Mathematics, especially Transformation Geometry. It is due to the fact that it can help students to find their own concepts of Transformation Geometry. The researchers are also expected to develop computer-based media, which can help students learn the Mathematics.[1]

[1]***Statement:*** Herewith, we have declared that this paper is our original work; so, it is not product of plagiarism and not yet be reviewed as well as be published by other scholarly journals.

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Interview with Yoga, a Student of Mathematics Education Department FKIP UMP (Faculty of Education and Teacher Training, Muhammadiyah University of Purwokerto), whose got C for Plane Analytic of Geometry, in Purwokerto City, Indonesia, on 10 November 2013.

Interview with Ani, a Student of Mathematics Education Department FKIP UMP (Faculty of Education and Teacher Training, Muhammadiyah University of Purwokerto), whose scored B in Plane Analytic of Geometry, in Purwokerto City, Indonesia, on 25 November 2013.

Interview with Anggit, a Student of Mathematics Education Department FKIP UMP (Faculty of Education and Teacher Training, Muhammadiyah University of Purwokerto), whose score in Geometry Analytic was B, in Purwokerto City, Indonesia, on 5 December 2013.

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Students of Mathematics Education
(Source: https://plus.google.com, 27/8/2015)

This research was conducted in two main steps: *preliminary step* or preparation step covering practical problem analysis by the researchers and practitioners; and *evaluation* step in which the researchers designed a solution based on the design and technology innovation principles, interactive cycle of try-out process and practical revision from the given solution, and reflection of the product. It was conducted from October to December 2013 at the Department of Mathematics Education FKIP UMP (Faculty of Education and Teacher Training, Muhammadiyah University of Purwokerto) in Central Java, Indonesia.

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