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Research paper

Preparing In-Service Teacher Using Dynamic Geometry Software

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Abstract

The use of technology is essential in teaching and learning process. Many researchers have already been implemented Dynamic Geometry Software (DGS) in teaching and learning process. Given the importance of DGS, it is necessary for in-service teachers to use the software in their teaching and learning. Hence, it is important to prepare in-service teacher in utilizing DGS through the professional development program. This is a qualitative research which describes a professional development program to facilitate in-service teachers in utilizing DGS. Both questionnaire and review measured in-service teachers' perceptions, knowledge and skills transfer, and impact for their practice. From the findings, four of five in-service teachers recognized that they can interact with geometric figures to move on to the next level by using DGS. The teachers felt that DGS has helped them to understand the mathematics concept and demonstrate their understanding in front of the class. Besides, DGS does not only offer opportunities for teachers and students to use them both at home and in the classroom, but they also provide a means for developing support and user communities reaching across borders especially in understanding of geometrical transformation. It has contributed that the teachers easily recognize the geometrical shapes interpretations dynamically on DGS.

Keywords: *DGS; Geometric Figures; Geometrical Shapes; In-Service Teachers; Perceptions*

1. Introduction

The use of technology is essential in teaching and learning process. In mathematics teaching and learning process, there is some dynamic geometry software such as GeoGebra, Maple, SPSS which helps mathematician in understanding the concept, reasoning and proving the mathematics formulas. Sometimes, it may be difficult to see such relations all together in a quick way using concrete materials [1]. Studies in the literature showed that dynamic geometry software provided students with the opportunity to better focus on abstract structures compared to concrete materials and paper-pencil activities [2-5]. The effectiveness of technology in teaching and learning to make students understand the mathematics concept.

Many scholars have shown the effectiveness of the dynamic geometry software in teaching and learning mathematics. Jones [6] posits that DGS helps students to elicit deductive reasoning since it has a mediational impact on students' thinking process. In different focus, Isiksal and Askar [7] conduct experimental design to examine students' achievement and self-efficacy with spreadsheet and DGS. They found that the DGS group scored significantly higher regarding the mathematics achievement and mathematics self-efficacy. Furthermore, the literature shows that DGS effective in developing spatial visualization skills [8-9]. The visualization skills are important in mathematics education since it can stimulate problem-solving skills [10].

Given the importance of DGS in the mathematics classroom, it is necessary for in-service teachers to use the software in their teaching and learning effectively. Hence, it is important to prepare in-service teacher in utilizing DGS through the professional development program. A number of researchers have elaborated the effective professional development. The elaboration showed that the effective professional development introduces new technologies in teaching and learning, as well as engage teachers in meaningful activities [11]. The effective professional development also yields knowledge and skills fulfillment, and impact on teacher practice [12].

Based on the rationale above, in this paper, we describe the professional development that has been held in one of the public schools in Yogyakarta. We also present evidence to support the effectiveness of the program with regard to teachers' perceptions, impact on their practice, and reflections.

2. Page layout

2.1. Context

This is a qualitative research which describes a professional development program to facilitate in-service teachers in utilizing Dynamic Geometry Software (DGS). The research was conducted by giving a questionnaire to the in-service teacher. Before the teachers fill out the questionnaire, the researcher gave a training related to the use of Dynamic Software in teaching mathematics, Desmos. There are 5 teachers which attend training using dynamic geometry software. There are 10 questions about the use of Dynamic Geometry Software in secondary school. The questions are shown in Table 1. All of the questions measured in-service

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teachers' perceptions, knowledge and skills transfer, and impact on their practice.

Table 1. The questions about utilizing DGS

No.	Questionnaire
1	After joining the training, I get to benefit from using DGS and will use it in class.
2	The training improves my knowledge and skills to plan and to organize the learning activity.
3	The training is essential as a mathematics teacher.
4	After training, I have a plan to implement DGS in a learning activity.
5	If I am doing research, I will use DGS to know its effectiveness for my students
6	After training, I will disseminate my knowledge about DGS to my colleagues in teaching mathematics.
7	I can keep up all of the materials while trained using DGS in teaching mathematics.
8	The materials related to DGS is interesting.
9	The trainers are mastered using DGS in learning mathematics
10	I understand the instruction written in the handout

2.2. Design of Professional Development Program

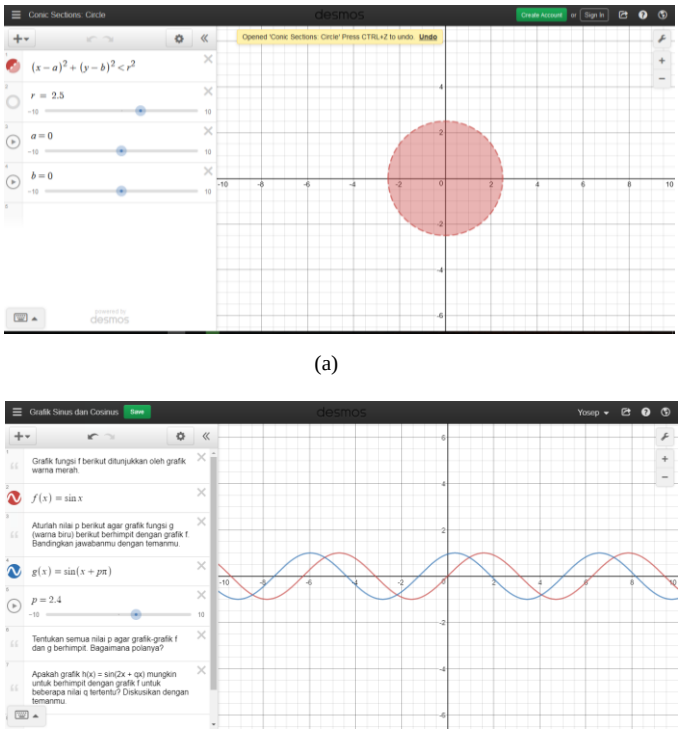
Before we conducted teacher professional development, we developed three training handouts to assist teachers in learning Desmos. The handouts were developed based on teacher competences standard and cover three mathematics topics, i.e. linear function, linear programming, and circle. Those handouts can be read on the following links: https://doi.org/10.6084/m9.figshare.6046931.v1, https://doi.org/10.6084/m9.figshare.6817118.v1, and https://goo.gl/jcxMZH.

The workshop had three sessions. The first session introduced the basic tools of Desmos for graphing and creating interactive activity. In demonstrating how to create the interactive activity, we used the topic of a linear function. The in-service teachers with the instructor's guidance followed step by step in making such activity. The second session was about linear programming. With the knowledge of basic tools of Desmos in their hands, the in-service teachers solve the linear programming problems using Desmos. Similarly, the in-service teachers solved circle problems in the third session. The problem-solving activities were intended to give the in-service teachers an example of DGS implementation in the mathematics classroom, especially for eliciting students' problem-solving skills.

3. Result and Discussion

Dynamics geometry software is important to make students visualize the geometric shape. DGS effective in developing spatial visualization skills. However, teachers, as the facilitator, need to be trained in utilizing DGS. They were introduced how to use DGS and its feature, to make interpretations of a trigonometry function, to solve linear program optimization problem, and to make a basic geometry shape such as circle and its transformation by using DGS. One of the participant's activities in making a basic geometry shape by using DGS is shown in Figure 1.

The participants are given the formula of a circle. They made a simple circle where the center (a, b) and the radius (r) are determined by using the slider. They explored the interpretation of a circle and its transformation by using DGS. After that, they were asked ten questions related to the use of DGS. The result of the questionnaire written by the participants is shown in Figure 2.



(a)

(b)

Fig. 1: (a) The Basic formula of a circle with *(a,b)* as center using DGS (b) The trigonometry interpretation

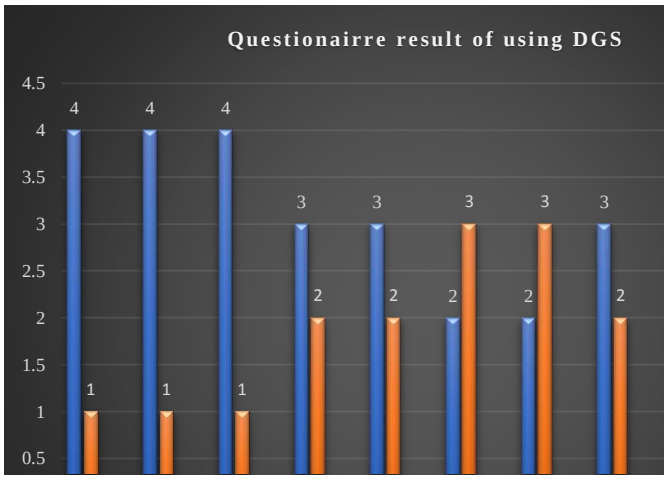


Fig. 2: The result of the questionnaire of using DGS

3.1. In-service teachers' perceptions

As their perception of using dynamic geometry software, 80% of the participants agreed that DGS helps them to interpret the concepts of mathematics. However, they consider to use it in class (see in Figure 2). Moreover, 80% of the participants agree that DGS improves their knowledge and skills to plan and to organize the learning activity. The participants agree that the use of technology is essential and interesting to implement it in class. In fact, most of them have already got a lot of training related to the use of dynamic software to visualize the mathematics concept.

According to the findings, some of the in-service teachers recognized that they can interact with geometric figures to move on to the next level by using dynamic geometry software. This finding is crucial to indicate Driscoll et al.'s [13] learning outcome for the relating figures and developing geometrical awareness. The teachers felt that DGS has helped them to understand the mathematics concept and demonstrate their understanding in front of the class. This use of technology to learn independently or

collaboratively was related to participants' self-reported gains, how supportive participant felt the school was, the level of academic challenge, teaching and learning interaction, active and collaborative learning, deep approaches to learning, and student satisfaction. Thus, it is important to note that there is a need for a design of an education program to improve students' visualization by using DGS.

3.2. Knowledge and skills transfer

Our second research question asked how important it is to the participants to have access to more or better technology for themselves or their students. As DGS does not only offer opportunities for teachers and students to use them both at home and in the classroom without any restriction, but they also provide a means for developing support and user communities reaching across borders. The collaboration between the teacher and the students also contributes to the equal access to technological resources and democratization of mathematics learning and teaching. [14]

The teachers were also reported frequently using technology to study on their own and with peers. The transfer of knowledge using DGS is supported by 60% of the participants have a plan to implement DGS in a learning activity and will use DGS to know its effectiveness for their students. Furthermore, the literature shows that DGS effective in developing spatial visualization skills [8-9]. The visualization skills are important in mathematics education since it can stimulate problem-solving skills [10].

3.3. Reflections

As a reflection of using DGS as the media of learning. The authors find that the 60% of the participants cannot keep up all of the materials while trained using DGS in teaching mathematics. (see Figure 2 item 7th). Besides, some dynamic geometry software such as Desmos can be used as a tool in such activity-based studies. Research conducted on dynamic geometry tools and the use of these tools in geometry has contributed to realizing the transformations in geometric environments [15-16].

DGS helps users to seek the properties of geometrical shapes [17]; for instance, when used reflection, rotation, transition, or dilation in Circle on DGS (see in figure 1), users easily recognize the geometrical shapes interpretations dynamically on DGS. This feature and other features of dynamic geometry software imply that new technologies should affect the visualization skills construct the understanding of a topic of mathematics [18-21]. In other words, the effective professional development also yields knowledge and skills fulfillment, and impact on teacher practice in class.

Several limitations of the present study should be noted. First, the proposed model shows how the perceptions such as usefulness, ease of use, behavioral intention, and actual system in DGS should be more explored. It can be conducted by the further research while the trainers will assist the in-service teachers in implementing the practice. Knowledge and skills transfer should be supervised. The digger effectiveness of DGS can be broadened by involving students' perception. Second, the current study did not survey in-service teacher's responses at multiple times. The researcher's approach does not capture the changes that may have occurred as a result of continued use of the system after the trial period.

4. Conclusion

In this paper, we highlighted various opportunities that dynamic mathematics software like Desmos can offer for the teaching of trigonometry function, linear program and geometry concepts. According to the findings, some of the in-service teachers recognized that they can interact with geometric figures to move on to the next level by using dynamic geometry software. The teachers felt that DGS has helped them to understand the mathematics concept and demonstrate their understanding in front of the class. Besides, DGS does not only offer opportunities for teachers and students to use them both at home and in the classroom without any restriction, but they also provide a means for developing support and user communities reaching across borders. This study conducted on dynamic geometry tools and the use of these tools in geometry has contributed to realizing the transformations in geometric environments. users easily recognize the geometrical shapes interpretations dynamically on DGS.

Several limitations of the present study should be noted. First, the proposed model shows how the perceptions such as usefulness, ease of use, behavioral intention, and actual system in DGS should be more explored. Knowledge and skills transfer of the teacher should be supervised. The digger effectiveness of DGS can be broadened by involving students' perception. Second, the current study did not survey in-service teacher's responses at multiple times. The researcher's approach does not capture the changes that may have occurred as a result of continued use of the system after the trial period.

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