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Prospective Elementary Teachers' Experiences in Implementing GeoGebra-based Mathematics Activities on Area of Rectangles

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ABSTRACT

This study aims to analyze the implementation of GeoGebra-based mathematics learning as software that can assist elementary school students in understanding the concept of the rectangle area. This research was conducted by giving a GeoGebra-based activity project to a group of prospective primary school teachers from the primary school teacher education study program from a public university in the province of Riau, Indonesia. They are involved in designing and asking students' responses to the implementation of GeoGebra-based mathematics learning on finding the rectangle area. The findings revealed that students have positive views and experiences in utilizing the use of this GeoGebra software in learning mathematics. However, some students have challenges operating the GeoGebra applet due to a lack of experience in using electronic devices. As for the operation, students should use this software more often so that they are more accustomed to knowing the features available in the GeoGebra software.

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INTRODUCTION

Technology is a necessity because the development of technology will affect essential activities in the mathematics learning process (Fendrik, Andhi, & Nurdiansyah, 2023). NCTM (2000) states that technology is essential in teaching and learning mathematics; It influences the mathematics that is taught and enhances students' learning. The use of technology in education is vital in learning, especially during the Covid-19 pandemic, which is still hitting Indonesia and several other countries. Mathematics is the primary substance of each technology; on the other hand, the technology supports mathematics teaching (Joshi, 2017). The use of technology such as interactive media for learning mathematics will make abstract mathematical concepts more natural because they can be displayed in visualizations. For students, visualization will be more fun and more effortless in learning mathematics (Ramdhani, 2017; Putra, Wulandari, Alpusari, & Hermita, 2021). One of the computer software that can be used in learning mathematics is

GeoGebra software. GeoGebra is a dynamic, accessible, and multi-platform mathematics software that combines geometry, algebra, tables, graphs, statistics, and calculus in one easy-to-use package that can be used for all levels of education. Dynamic means that users can generate interactive math applications. Free means that GeoGebra can be used and copied for free and includes open-source software so that anyone can change or improve the program. Multi-platform means GeoGebra is available for all types of computers, such as PC, tablets, and various computer systems such as Windows, Mac OS, and Linux (Putra, Wulandari, Alpusari, & Hermita, 2021; Hidayat, & Tamimuddin, 2015). With various facilities owned, GeoGebra can be used as a medium for learning mathematics to demonstrate or visualize mathematical concepts and a tool for constructing mathematical concepts (Tanzimah, 2019).

In this study, we designed a GeoGebra activity, commonly known as an applet related to the area of a rectangle, where students were asked to find the area of the rectangle themselves. From this activity, students not only use formulas to find the area of a rectangle, but they can also find it in the GeoGebra applet by counting the boxes that will appear if the length and width are shifted. The rectangular area is a topic that requires demonstration, so it requires media in the learning process. Computer-based media visualizes the area of a rectangle, making it easier and more fun for students (Clements & Battista, 1994). GeoGebra, which stands for Geometry and Algebra, contains Geometry and Algebra facilities to combine rectangular visualization and exploration of area formulas. In this study, the learning design of the rectangular area concept is based on GeoGebra software that elementary school students can use (Putra, Panjaitan, Putri, Wulandari, Hermita, & Dahnilsyah, 2021).

Therefore, we are interested in investigating the experiences of prospective elementary school teachers with GeoGebra on certain mathematics learning activities. Thus, this study aims to analyze prospective elementary teachers' first experiences in designing and implementing GeoGebra- based mathematics learning to assist elementary school students in understanding the concept of the rectangular area. In addition, the use of GeoGebra software can also help and support prospective elementary school teachers in developing their ability to teach mathematics as an innovation in learning mathematics (Fendrik, Alpusari, Yosi, & Widyanthi, 2018; Fendrik, & Elvina, 2018).

METHOD

This research is part of the researchers' main project on designing GeoGebra-based mathematics learning. In this study, we used a descriptive method to describe the first experience of prospective elementary school teachers with GeoGebra-based mathematics learning activities. This method was chosen because we wanted to analyze the experience of prospective elementary school teachers in using GeoGebra for elementary students.

The participants of this study were four second-year prospective elementary teachers (as a team) from the Department of Elementary School Teacher Education from a public university in Riau, Indonesia. The participants have completed two mathematics courses and one mathematics education course. Therefore, they already have adequate knowledge about the given mathematical activity. During data collection, all prospective elementary school teachers were taking a mathematics education course about teaching mathematics for upper grade emelentary school. Meanwhile,to find out the experience of prospective elementary teachers.

The prospective elementary teachers tested the designed GeoGebra activity with four elementary school students (three fourth grade students and one sixth grade student) in Rokan

Hilir Regency, Riau Province, Indonesia. The selection of students was based on the ease of obtaining data to be tested by prospective elementary school teacher students, and this was done because of the social restriction policy during the Covid-19 pandemic.

RESULTS

Researchers found that elementary school teacher students designed GeoGebra activities from the work of Untung Trisna. S as the first author uses GeoGebra and published it at https://www.GeoGebra.org/m/r7snvbm4 under the title "area of a rectangle" which is available in the GeoGebra applet. The step taken is to edit the applet to follow the level of understanding and ability of elementary school students. The following are the findings obtained from the results of this study.

Steps to design GeoGebra applet by prospective elementary school teachers

The first step someone could do is search "GeoGebra" from google chrome and then sign in to the GeoGebra application. In the next step, one can edit a project from other authors. In this study, the prospective elementary teachers first searched for the appropriate material by clicking on the Resource section and typing the keyword "area of a rectangle", and they found the project made by Untung Trisna. S (Fig. 1.).

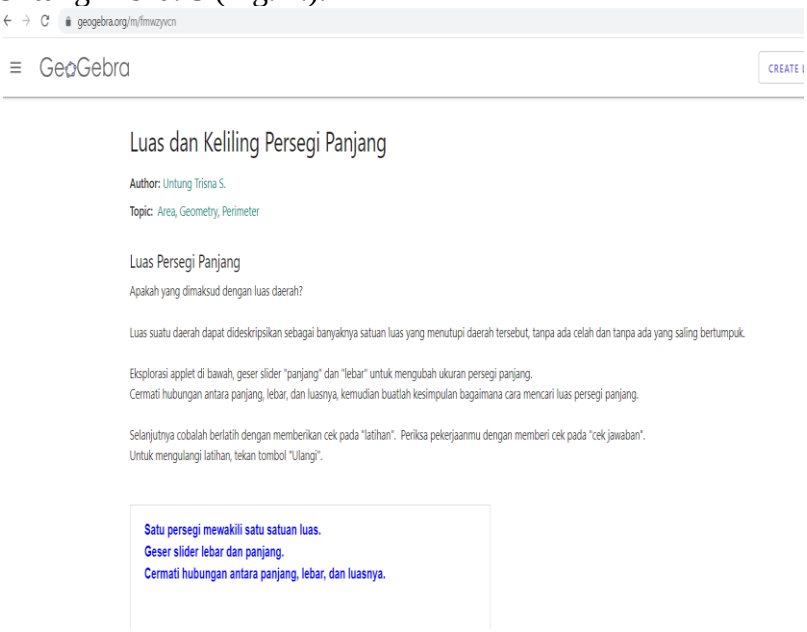

Figure 1. Display of the GeoGebra applet of area of a rectangle

Furthermore, in the GeoGebra activity, the prospective elementary teachers add material and some questions to find out how far students' understanding and thinking skills are. In this activity, they expected students could first read material related to rectangles, and then, they could try and understand in advance the examples of the GeoGebra applet by shifting the length and width according to the numbers they wanted. Here are the steps for designing a GeoGebra applet by prospective elementary school teachers.

- First step is to search the applet to be downloaded in the GeoGebra resources. Here, the prospective elementary teachers use the keyword "*luas dan keliling persegi panjang"* (Fig. 2.).

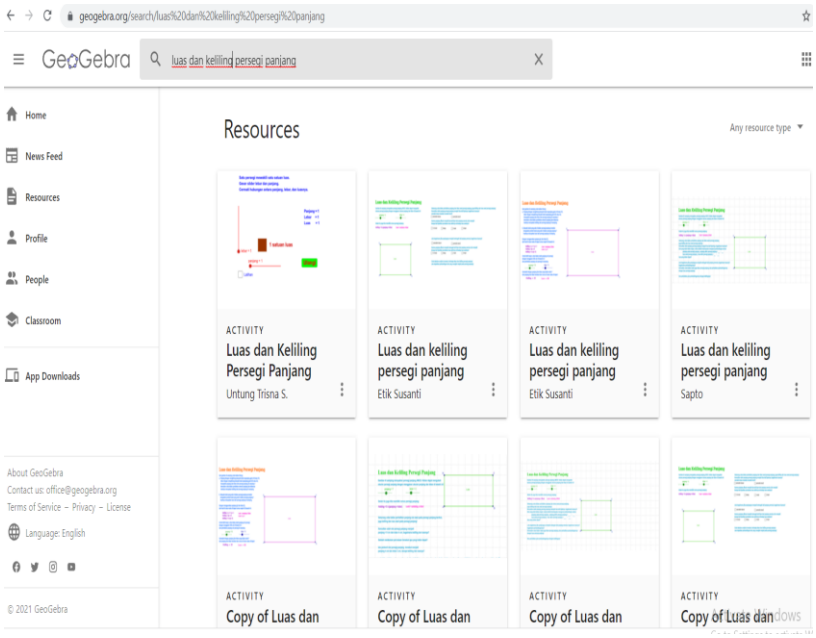

Figure 2. Search for the applet to download on the GeoGebra webiste

- Then, they clicked the applet designed by Untung Trisna S and then donwloaded it. To do so, they clicked the three-dot button, and clicked **download** (Fig. 3).

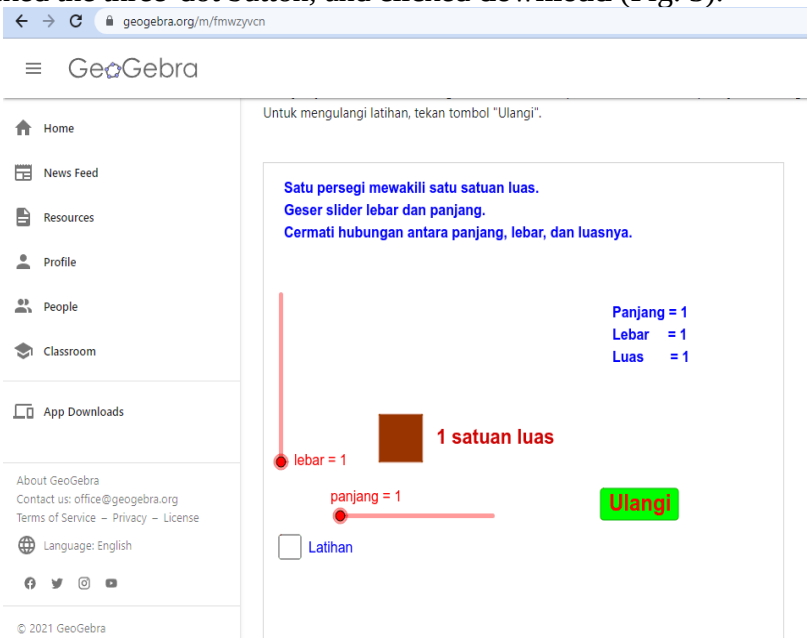

Figure 3. GeoGebra applet downloaded

- After the applet is downloaded, the prospective elementary teachers opened on the GeoGebraapplication (GeoGebra version 5) as presented in Fig. 4.

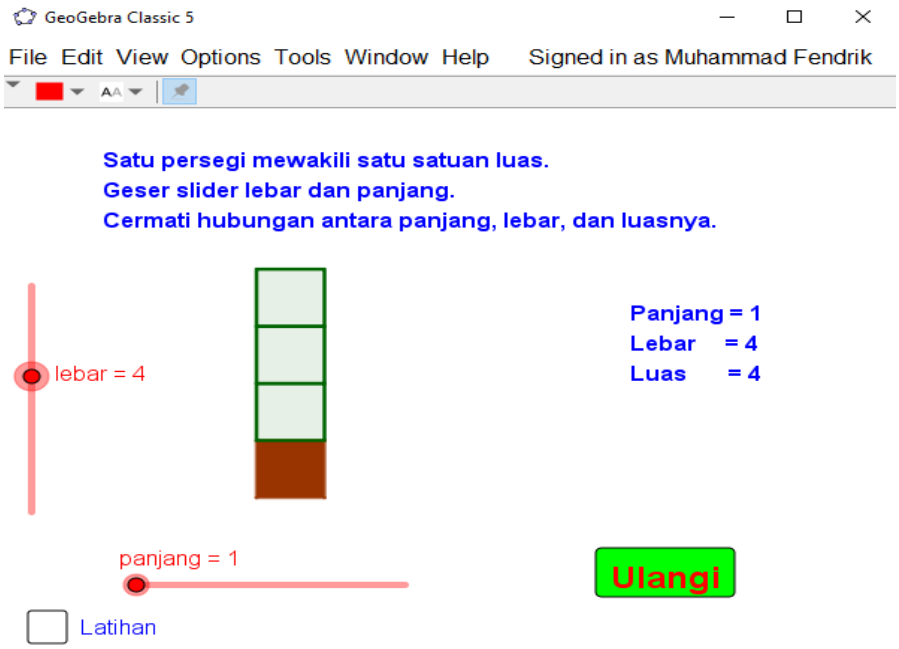

Figure 4. GeoGebra activity presented in GeoGebra version 5

- To be able to edit the applet, they clicked the text **edit**, then several menu options would appear, then clicked onthe **object properties** section (Fig. 5.).

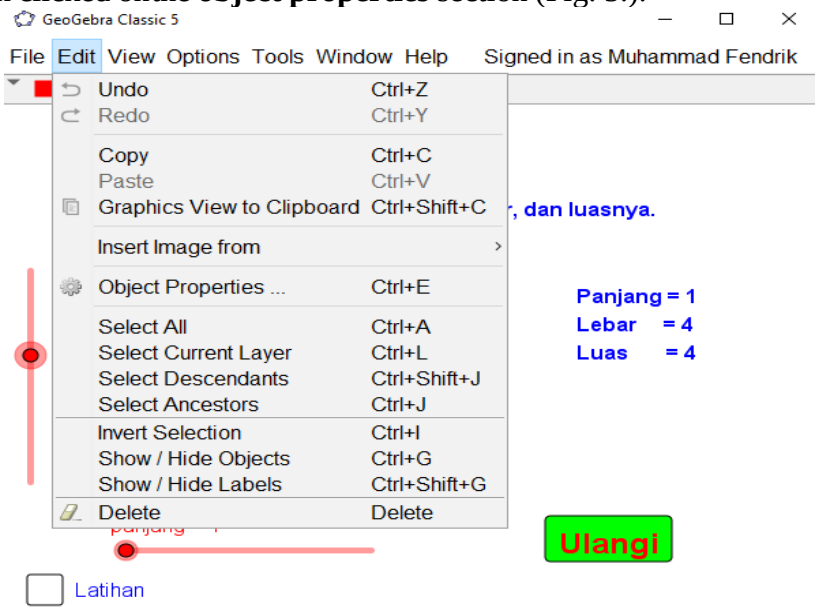

Figure 5. Editing GeoGebra applet

- After that, the settings panel will appear on the right, in this section the prospective elementary teachers change the color of each text or applet and increase the total length and width for the rectangular image. The way to change the color is just by clicking on which text someone want to change, then select the **color** section, and one just has to choose what color you want to use (Fig. 6.).

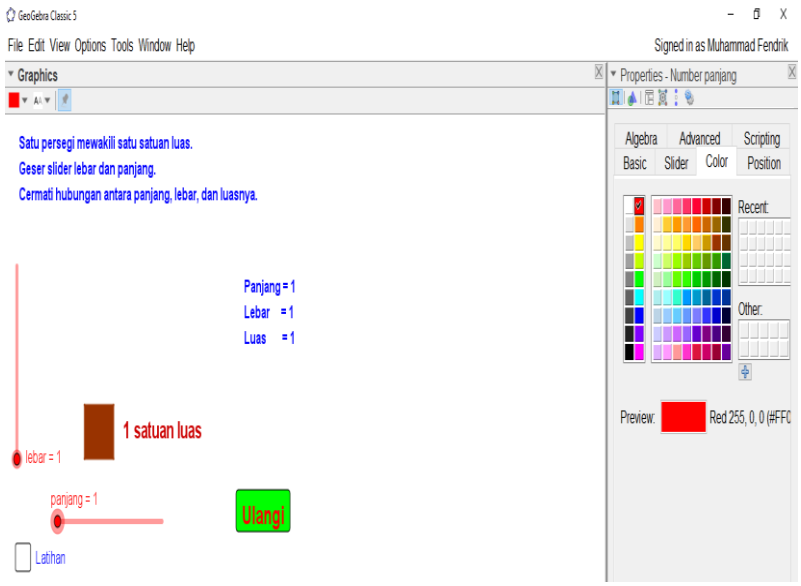

Figure 6. Change GeoGebra applet color

- Next, to add the amount in the length and width of the rectangle formed, the settings will appear as shown by clicking on the width. Then click the slider section and change the number in the maximum section and the minimum section determines the minimum number of boxes that will form a rectangle (Fig. 7.).

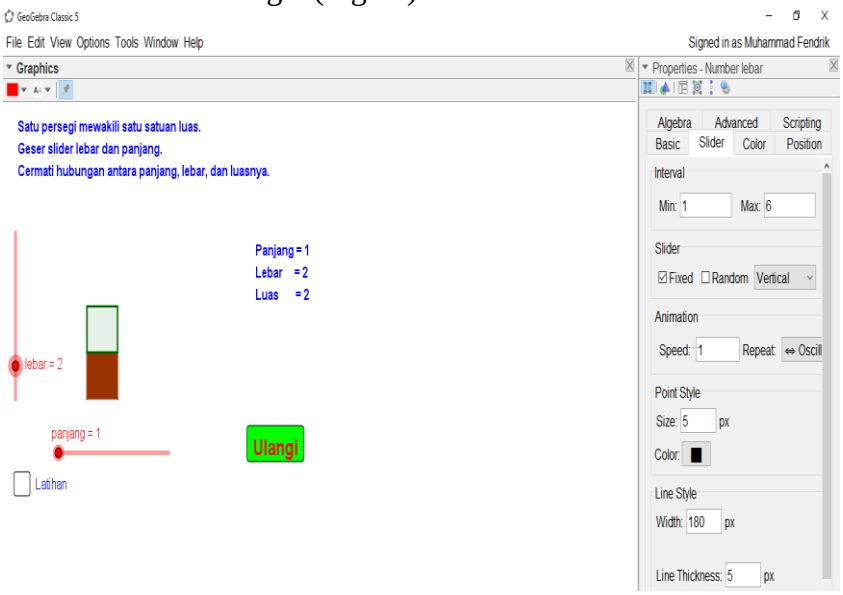

Figure 7. Increase the number of lengths and widths

- After editing the applet, one needs to make sure any text or other materials in the applet are locked so they don't slide around when opened. One does this by clicking on the text section or other icon that one wants to lock and then clicking on the icon that resembles a locked padlock as shown in the red box.
- After finish editing, save it so that each edited part can be saved by clicking the file icon and several menus will appear, then select save (Fig. 8.).

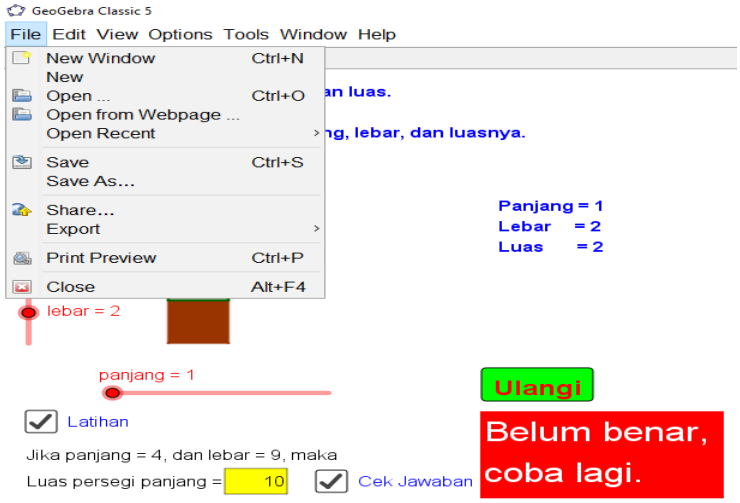

Figure 8. Save the edited GeoGebra applet

- The GeoGebra applet is finished to be edited and ready to be used to create an activity.

After trying and understanding the example of GeoGebra- based mathematics learning design, students can do exercises to find out how much they understand the GeoGebra applet by checking the small box that says “Practice”.

Then, if students have found the answer, they can type it in the yellow box next to the question. Next, students can check the small box that says “Check Answers” to find out whether they have managed to answer the question correctly. If students still want to practice their understanding, they canpress the box that says “Repeat” to answer other questions. Next, students were asked to answer four questions. This question aims to determine the extent of students' understanding and critical thinking after using the GeoGebra applet. The analysis of the findings that can be seen from this project is to design a GeoGebra-based mathematics lesson to find the area of a rectangle and test the GeoGebra activity with elementary school students (Fig. 9.), which we can explain below.

Figure 9. The representation of the task on GeoGebra applet

The results of the GeoGebra activity to elementary school students by prospective elementary teachers

In the pilot phase of this GeoGebra activity, prospective elementary school teachers visited elementary school students one by one to their homes. It happened because of the Covid-19 pandemic situation. Therefore, they could not do it together and were constrained by the residence of each member of the different group, so they chose to do a trial by dividing the task. In the process, prospective elementary teachers provided GeoGebra activities through a link that is accessed from the team member's cellphone and then did a screen recording of the activities carried out by students, which will later be used as supporting reports on the results of this pilot experiement.

First, the students did not know what GeoGebra was, so prospective elementary teachers explained it first to the students. Then they introduced the application to students. First, students felt that using this application was too complicated, but after prospective elementary teachers explained further, students tried to practice it while saying "it was easier than using the traditional learning method". The results can be seen from the responses of the following students.

Based on video recordings and conversations from interviews during testing of GeoGebra-based activities, it was found that the use of GeoGebra software was constructive and made it easier for students to understand and solve problems. As the results of the interview with student A (grade VI) through the following GeoGebra activity.

The Interviewer	:	Does this GeoGebra application make it easier for you to complete math tasks? Or not at all? Give a reason!
Student A	:	Yes, because it makes math tasks easier from this application
The Interviewer	:	What part of mathematics when you learn GeoGebra?
Student A	:	Area of rectangle

From the results of this trial, it can be concluded that student A is very happy with this GeoGebra application. Because he feels interested and challenged in doing new things that he has never tried to use at all. In doing this activity, student A is already proficient in using mobile phones, so he has no difficulty typing answers to the questions provided in the GeoGebra activity. Student A also feels that using this GeoGebra activity can make it easier for him to find the area of a rectangle.

Next is student B (grade IV), who likes GeoGebra activities in the material of rectangular area. This student liked it because it was easy to count the boxes in GeoGebra-based learning activities. Based on the results of video recordings and interview conversations, it was found that student B liked the GeoGebra software because this software helped him calculate squares to determine the area of the rectangle, as the results of the interview conversation are as follows.

The Interviewer	:	Does this GeoGebra application make it easier for you to complete math tasks? Or not at all? Give a reason!
Student B	:	Easy because it can be counted from the box
The Interviewer	:	How to get the answer from the area of the rectangle that has been worked out?
Student B	:	By counting squares

Based on the results of this pilot experiment, it can be concluded that student B is pleased and interested in this GeoGebra activity. In doing this activity, student B is not proficient in using cellphones, so he has difficulty typing answers to the questions provided in the GeoGebra

activity. In using this GeoGebra activity, student B can be helped in answering questions because he can find the area of a rectangle by counting the boxes that appear if the length and width of the GeoGebra applet are shifted.

Next is student C (grade IV). It was found that the GeoGebra software helped student C more easily understand how to find the area of a rectangle.

The Interviewer	:	Does this GeoGebra application make it easier for you to complete math tasks? Or not at all? Give a reason!
Student C	:	It's very easy for me to understand and easy to understand
The Interviewer	:	What do you get after studying the material for the area of a rectangle by using this GeoGebra application?
Student C	:	We are easier to understand in using GeoGebra

From the results of trials using the GeoGebra application in learning mathematics related to rectangular area material, student C can easily understand the material by using the GeoGebra application. Student C said, “it is easier to use this than usual”. Student C is also quite proficient in using cellphones, so student C is easier to learn when using the application.

Then student D (grade IV) can understand how to use GeoGebra applet, so student D immediately starts working on the questions in the GeoGebra application. Moreover, student D tries to work on the questions in the GeoGebra application, and student D begins to write down the answers, then the prospective teacher checks whether the questions he is working on are correct.

The Interviewer	:	Are you able to understand how to do problems with this application?
Student D	:	Well that's that then

Based on the results of this trial, prospective elementary school teachers can conclude that children like this application because learning with this application is very interesting and makes it easier for students to do math problems.

DISCUSSION

From some of the students that prospective elementary teachers have tested to work on the problems in the GeoGebra application, we got some findings, such as student obstacles in the form of being less proficient in using cellphones which have an impact on the students’ lack of skill in utilizing GeoGebra-based math learning activities. Therefore, students need to know and understand the use of mobile phones in education (Molnar, 2014)

With this GeoGebra activity, students will be more interested and feel challenged to learn because they can seek and find the answers themselves (Rabi, Fengqi, Aziz, Ullah, & Abduraxmanovna, 2021). After prospective elementary teachers conducted a test with several students, the students were pleased and interested in doing it because they thought that the method in GeoGebra’s activity would make it easier for them to find the area of a rectangle. In addition, students can increase their understanding and thinking in learning mathematics, especially in the area of rectangles (Sachdeva, & Eggen, 2021; Kurniawati & Amir, 2022). Students no longer look for answers by using formulas that they do not necessarily remember and understand how to use them. With this project, students can think that learning mathematics does not just always use formulas, but there are other ways like in our project, namely students can count the boxes in the GeoGebra applet to help and make it easier for them to find the area of rectangle. In addition, with this project, students are no longer looking for answers by writing them down in a book which can cause students to feel bored and not interested in doing it,

resulting in problems in the learning process. However, with this GeoGebra activity, students can use their cellphones/laptops to study.

CONCLUSION

The conclusion they can draw is that students can work on questions well in the GeoGebra application. This application is fascinating and accessible for students in conditions like today in the Covid-19 pandemic. The conclusion we get is that most students are not familiar with learning media so that when they are introduced for the first time, students tend to think using the media is more complex, but after trying it, students are very interested in using the media, because there is a section to check the right and wrong answers. When doing the pilot project with the students, it was also smooth because the students already had the ability and were quite proficient in using cellphones, it is just that when testing was carried out at night, and the network was also unstable. Finally, we can say that GeoGebra makes it easy for students to work on questions. GeoGebra gives interest to students so that they become more enthusiastic in learning and can feel learning in real terms because learning mathematics is a process of providing learning experiences to students with a series of planned activities so that they acquire new knowledge about mathematics through various mathematical skills.

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