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TRAINING AND ASSISTANCE IN USING GEOGEBRA TO IMPROVE THE COMPETENCE OF HIGH SCHOOL MATHEMATICS TEACHERS

Darsih Idayani[1]*, Wahyu Hidayat[2], Selly Anastassia Amellia Kharis[3], Asmara Iriani Tarigan[4], Sumartono Sumartono[5]

[1*,2,3,4]Prodi Matematika, Universitas Terbuka, Banten 15437, Indonesia

[5]Prodi Perencanaan Wilayah dan Kota, Universitas Terbuka, Banten 15437, Indonesia

[1*]darsih@ecampus.ut.ac.id, [2]wahyuhidayat@ecampus.ut.ac.id, [3]selly@ecampus.ut.ac.id, [4]asmara@ecampus.ut.ac.id, [5]sumartono@ecampus.ut.ac.id

Abstract: *Mathematics teachers must adapt to technological developments in the digital era. Among other problems related to learning mathematics, students tend to feel bored and uninterested in mathematics. At the same time, most teachers need help keeping up with fast technology developments. The solution offered is training and mentoring activities for using the GeoGebra software in mathematics learning in South Tangerang City in collaboration with the Subject Teacher Deliberation of Mathematics or MGMP. The material presented was about introducing GeoGebra, graphs, and function operations. Moreover, it was about solving linear programming, geometry, and calculus in GeoGebra. The pretest and posttest results showed increased participants' knowledge about GeoGebra utilization. This condition is indicated by the significance value of the t-test, which is less than 0.05 and less than 0.001. In addition, activity evaluation was carried out by filling out evaluation forms and interviews. The evaluation results show that the training and mentoring activities have enabled participants to gain new knowledge about the GeoGebra as needed in teaching mathematics in high school.*

Keywords: *Mathematics; GeoGebra; Teacher's competence.*

* Corresponding author :
Email Address : darsih@ecampus.ut.ac.id (Universitas Terbuka, Tangerang Selatan)
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INTRODUCTION

Currently, technology is developing rapidly, including in the field of education. All parties, including teachers, are required to be able to follow technological developments. Teachers are forced to follow technological developments faster than they should. Progress in the field of educational technology and learning technology requires the use of various learning media and increasingly sophisticated equipment. Currently, education lives in a media world, where learning activities using conventional learning material delivery systems that prioritize the lecture method are reduced and replaced with modern learning material delivery systems that prioritize students' role in using multimedia technology and the role of teachers as facilitators. Teachers must have the

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required competencies to keep up with technological developments.

However, according to Hidayati et al., teacher competence in 34 provinces in Indonesia is low in two areas of mastery: pedagogical and professional competence[1]. In South Tangerang City, the average Teacher Competency Test or UKG score for high school teachers is 69,6, the average pedagogical score for all teachers is 56,27, and the average professional score for all teachers is 64,37. Meanwhile, the average UKG score for all teachers is 61,94 [2]. This condition is unfortunate, considering the teacher's role in learning is very important.

In Indonesia, there is an association of teachers, namely the Subject Teachers' Deliberation or MGMP. One of the aims is to increase knowledge and skills with a more professional learning innovation approach. Therefore, the community service team of the Mathematics Study Program Universitas Terbuka invited MGMP Mathematics at South Tangerang City to partner in community service activities to increase the competence of high school mathematics teachers. MGMP of South Tangerang City is chaired by Sulandari, M.Pd., a mathematics teacher at 12 South Tangerang State High School on Raya Cilenggang Street 1 Serpong. The MGMP consists of around 150-200 state and private high school mathematics teachers spread across all state high schools in South Tangerang.

A meeting with the South Tangerang City MGMP was held to analyze the needs of high school mathematics teachers. Sulandari, M.Pd as Chair of the South Tangerang City High School Mathematics MGMP, and Ahmad Fauzi, S.Mat as the Development and Training Section, attended. Mrs. Sulandari, M.Pd, believes that most high school mathematics teachers in South Tangerang need help keeping up with technological advances in education and learning. Many teachers are comfortable with the old ways. They are also busy at school, so they feel reluctant to learn technology that can help the learning process. As a result, teachers use makeshift learning media in the learning process, such as power points with pictures obtained from books or searching on search engines. This situation is exacerbated by the stigma of mathematics as problematic compared to other subjects. So, learning innovation is needed in the mathematics learning process to make it easier for students to understand mathematics material.

An innovation in mathematics learning is using mathematics software in the learning process, such as GeoGebra software. GeoGebra is an open-source dynamic mathematical software program (available for free) created by Markus Hohenwarter for his Master's thesis project at the University

[1] Sri Hidayati et al., *Peran Musyawarah Guru Mata Pelajaran (MGMP) Dalam Meningkatkan Mutu Pembelajaran Di SMA* (Jakarta: Puslitjakdikbud, 2020).
[2] Kemendikbud, "Data UKG," *Https://Npd.Kemdikbud.Go.Id/?Appid=ukg.*

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of Salzburg, Austria[3]. GeoGebra's official website is http://www.geogebra.org, which features the latest version of the software, access to GeoGebraWiki and User Forums, related publications, and information regarding regional GeoGebra Institutes. GeoGebra software can create images or animations of flat shapes, geometric shapes, straight lines, linear, quadratic, trigonometric, etc. All this is found in materials on geometry, linear programming, linear equations, trigonometry, etc. With the help of GeoGebra software, teachers are expected to be able to create exciting learning media, and students can understand mathematics material easily.

Several studies have been conducted in the last ten years regarding using GeoGebra in mathematics learning. Shadaan and Eu indicated that students in the experimental group were superior to students in the control group, and there was a positive perception of using GeoGebra in learning circle material[4]. Majerek said that GeoGebra could be used as a mathematics learning medium to demonstrate or visualize mathematical concepts and as a tool to construct mathematical concepts[5]. Arbain and Shukor's research shows positive perceptions and better learning achievements of students who use GeoGebra[6]. The results are supported by the opinion of Asngari, who said that GeoGebra can help in learning mathematics, especially in studying geometry efficiently and in a fun way[7]. Nur also believes that GeoGebra is a relatively effective and efficient program for visualizing mathematical objects, especially function and graph material[8]. Nur'aini, Harahap, Badruzzaman, and Darmawan also said that the GeoGebra application media catalyzes practical work[9]. In addition, Kramarenko, Pylypenko, and Muzyka concluded that using GeoGebra Dynamic Mathematics in stereometry learning positively influenced students' STEM (Science, Technology, Engineering and Math) competencies[10]. Meanwhile, according to Nuritha and Tsurayya, learning videos assisted by GeoGebra are effectively used as media or tools to help students learn mathematics[11].

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[3] Subiono, *Geogebra* (Surabaya: Matematika ITS, 2020).
[4] Praveen Shadaan and Leong Kwan Eu, "Effectiveness of Using Geogebra on Students' Understanding in Learning Circles," *The Malaysian Online Journal of Educational Technology* 1, no. 4 (2013): 1–11.
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[8] Isman M Nur, "Pemanfaatan Program GeoGebra Dalam Pembelajaran Matematika," *Delta-Pi: Jurnal Matematika dan Pendidikan Matematika* 5, no. 1 (January 11, 2017): 10–19.
[9] Indah Linda Nur'aini et al., "Pembelajaran Matematika Geometri Secara Realistis Dengan GeoGebra," *Matematika* 16, no. 2 (December 23, 2017): 1–6.
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From the results of these studies, it can be concluded that GeoGebra can help teachers in the mathematics learning process, so it is essential to increase teachers' knowledge and skills in using GeoGebra for effective mathematics learning. Several pieces of training regarding using GeoGebra for middle and high school teachers and students have been carried out[12]. However, no one has focused on high school material according to the current curriculum.

Based on these problems, the PkM team and the South Tangerang City High School Mathematics MGMP partner worked together to improve the competency of high school mathematics teachers by increasing teachers' knowledge and skills in using and utilizing GeoGebra software for high school mathematics learning. Training and mentoring are carried out to achieve this goal. The material presented is an introduction to GeoGebra, graphs and function operations, solving linear programming, geometry, and calculus in GeoGebra. A posttest and pretest were conducted to find out the change in teacher competence, and the activities were evaluated.

METHOD

GeoGebra training is carried out using lecture and practical methods with stages of preparation (*analysis design develop*), training implementation, and evaluation based on the analysis design development implement evaluate (ADDIE) training process[13]. The ADDIE training process involves the following steps: training needs analysis (analysis), designing the overall training programme (*design*), developing the programme by collating the necessary material (*develop*), implementing the programme (*implement*), and evaluating the effectiveness of the programme (evaluate)[14].

First, the community service team met with MGMP South Tangerang to analyze needs. Then, the team prepares training materials for the preparation stage by writing and reviewing

[12] I Putu Wisna Ariawan, "Pelatihan Pemanfaatan Software GeoGebra Untuk Menunjang Pencapaian Standar Kompetensi Guru Matematika SMP Di Kecamatan Abang Kabupaten Karangasem," *Jurnal Widya Laksana* 3, no. 2 (February 1, 2017): 89; Endang Habinuddin et al., "Peningkatan Keterampilan Penggunaan Software GeoGebra Untuk Pembelajaran Matematika Guru SMP Cimahi," *Sigma-Mu* 8, no. 1 (January 1, 1970): 7–16; Dian Nataria Oktaviani, Rizqi Amaliyakh Sholikhakh, and Herani Tri Lestiana, "Pendampingan Penggunaan Geogebra Untuk Guru Matematika SMP/MTS Se Kecamatan Talang Kabupaten Tegal," *JPPM (Jurnal Pengabdian dan Pemberdayaan Masyarakat)* 2, no. 1 (March 30, 2018): 153–156; Nur Sahara Panggabean, Masdelima Azizah Sormin, and Lisna Agustina, "Workshop Pemanfaatan Media Pembelajaran GeoGebra Untuk Meningkatkan Kompetensi Guru Matematika," *Martabe : Jurnal Pengabdian Kepada Masyarakat* 2, no. 1 (June 14, 2019): 40–44; Natalia Rosalina Rawa, Maria Editha Bela, and Melkior Wewe, "Pendampingan Pembelajaran Matematika Asyik Dan Menyenangkan Melalui Penerapan Software GeoGebra Dan Microsoft Mathematics Bagi Guru Matematika SMA Se-Flores," *Jurnal Abdimas Ilmiah Citra Bakti* 1, no. 1 (April 15, 2020): 20–27; Sigit Pancahayani et al., "Pelatihan Geogebra Bagi Guru Di Kota Balikpapan," *Dinamisia: Jurnal Pengabdian Kepada Masyarakat* 6, no. 4 (August 31, 2022): 869–875; Asmara Iriani Tarigan et al., "Peningkatan Kompetensi Guru Matematika Dan Siswa SMA Dengan Pemanfaatan Software GeoGebra," *I-Com: Indonesian Community Journal* 3, no. 1 (March 8, 2023): 149–160.

[13] Gary Dessler, *Human Resource Management*, 16th ed. (New York: Pearson Education, 2020).

[14] Titus De Silva, *Integrating Business Management Processes: Support and Assurance Processes*, 1st ed., vol. 2 (Taylor & Francis, 2021).

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training modules. Next, the team surveyed the training site.

At the training implementation stage, participants were given introductory material to GeoGebra and its use in creating and solving mathematical problems following high school material, namely graphs and function operations, solving linear programming, geometry, and calculus in GeoGebra. Next, training participants are given math problems related to this material to be solved using GeoGebra. In this stage, the community service team accompanies each training participant. At the end of the activity, the training participants were given assignments to practice at home and discussed together at the next training meeting. The team provided the project to determine the extent of the development of participants' skills regarding using GeoGebra. Apart from that, during the training, participants were given a pretest and posttest questions to see how their knowledge increased regarding using GeoGebra.

The data from the pretest and posttest results were then processed using a comparison test of two means to see whether, after the training was carried out, there was a significant increase in participants' knowledge regarding the use of GeoGebra. The data normality test is needed to determine the test statistics used. Here, the One-Sample Kolmogorov-Smirnov test will decide whether the pretest and posttest samples come from a normally distributed population. If it meets normality requirements, a paired sample t-test will be used. In contrast, if it does not meet normality, then nonparametric statistics will be used, which does not use any presumption of knowledge about the underlying distribution of the population[15]. All data processing will use SPSS software. At the end of the activity, the community service team evaluated by asking all training participants to fill out an evaluation form to implement the action. In addition, in-depth interviews were conducted with representatives of training participants.

RESULTS AND DISCUSSION

Preparation

The community service team held a meeting with the MGMP team to conduct a needs analysis, which Ms Sulandari, M.Pd as Chair of the High School Mathematics MGMP in South Tangerang and Mr Ahmad Fauzi, S.Mat as the Development and Training Section, attended. Mrs. Sulandari, M.Pd, believes that most high school mathematics teachers in South Tangerang have difficulty keeping up with technological advances in education and learning. Therefore, there is a desire to prepare human resources (teachers) who can use ICT in teaching and learning with students.

[15] Ronald E. Walpole et al., *Probability and Statistics for Engineers and Scientists* (Boston: Pearson Education, Inc., 2011).

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To fulfill the partners' wishes, the community service team designed training activities for high school mathematics teachers using the GeoGebra application. The team met again to present the activity plan, and the MGMP team signed a letter stating their willingness to complete the training.

Figure 1. The Meeting with South Tangerang City Mathematics MGMP

Training Implementation and Evaluation

GeoGebra training was held in three meetings, all conducted online via Zoom. The number of participants was 13 mathematics teachers from 10 senior high schools and 1 vocational high school, i.e. South Tangerang 2, 4, 5, 7, 8, and 9, Serang 3, Olahraga Pembangunan Jaya Raya, Nurul Fikri Serang, and 1 Waringinkurung Senior High School, as well as An-Nurmaniyah Vocational High School. At the first meeting, participants worked on pretest questions with an average score of 3,8 out of a maximum of 10. It shows that participants still have insufficient knowledge about Geobegra. Next, participants were given Geogebra training through direct delivery of material and practice. The material concerns graphs and functions, solving linear programs, and calculus (see Figure 2).

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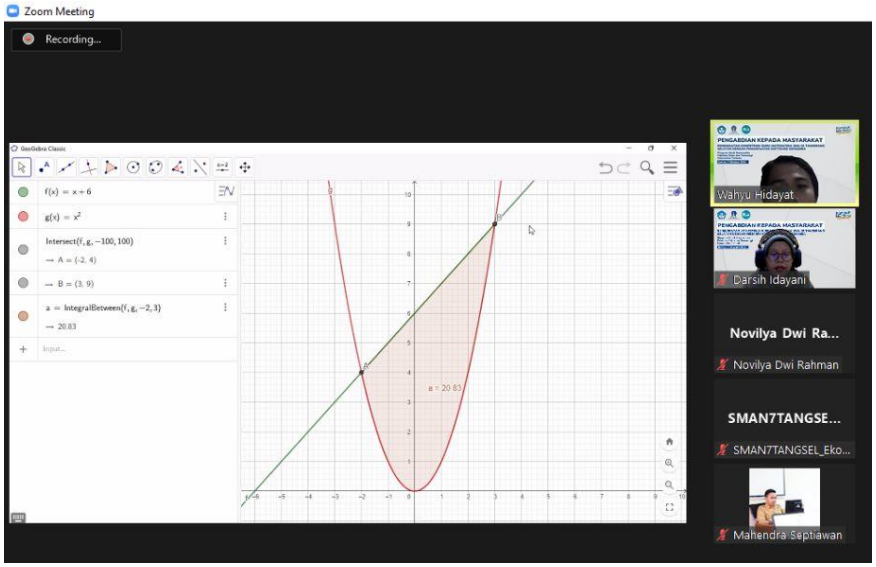

Figure 2. The online training

Apart from material and practice, participants are given assignments related to the material that has been presented (see Figure 3). However, due to the busyness of the participants, not all of them completed the assignments given. At the end of the activity, participants worked on posttest questions with an average score of 5,9 out of 10. Compared with the pretest results, it showed an increase in the participants' knowledge of GeoGebra (see Figure 4).

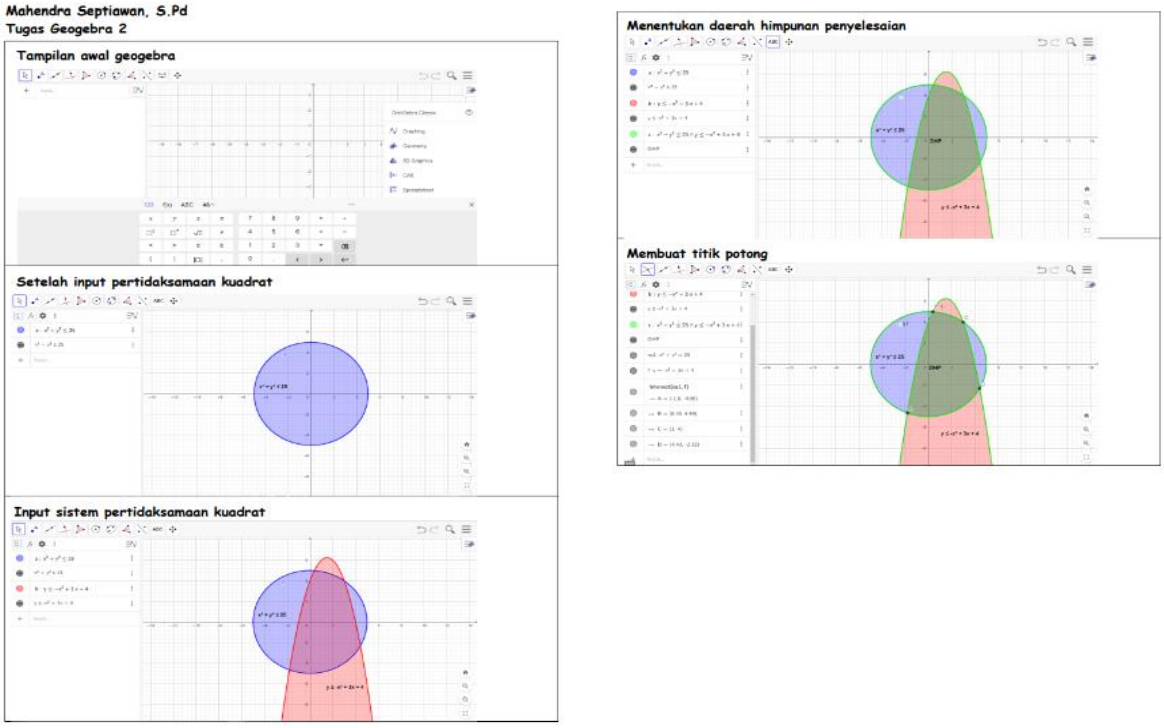

Figure 3. Assignments submitted by participants

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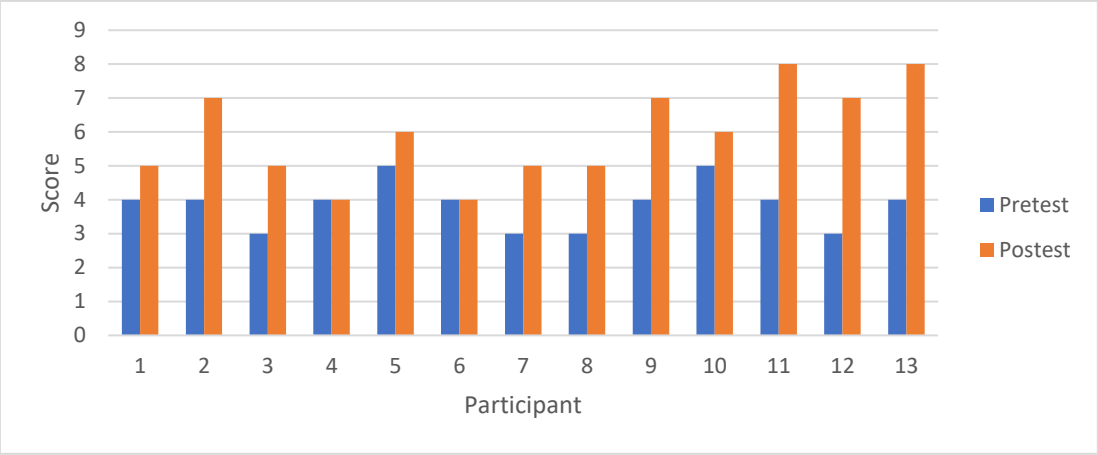

Figure 4. Comparison of pretest and posttest results

A hypothesis test was carried out to determine the significance of the knowledge increase. Asymp Value. Sig. (2-tailed) pretest and posttest data are more excellent than 0.05, respectively 0.176 and 0.123 (see Table 1). These scores show that the pretest and posttest data are typically distributed. Thus, a parametric statistical test, namely the paired sample t-test, can be carried out.

Table 1. Pretest and posttest data normality test results

One-Sample Kolmogorov-Smirnov Test

			Pretest	**Postest**
N			13	13
Normal Parameters[a,b]	Mean		**4.0000**	**5.9231**
	Std. Deviation		0.81650	1.38212
Most Extreme Differences	Absolute		0.197	0.209
	Positive		0.197	0.209
	Negative		-0.197	-0.167
Test Statistic			0.197	0.209
Asymp. Sig. (2-tailed)[c]			**0.176**	**0.123**
Monte Carlo Sig. (2-tailed)[d]	Sig.		0.182	0.123
	99% Confidence Interval	Lower Bound	0.172	0.114
		Upper Bound	0.192	0.131

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. Lilliefors' method based on 10000 Monte Carlo samples with starting seed 926214481.

The t-test results show a significant difference between the average pretest and posttest scores of Geogebra training participants (see Table 2). This condition is indicated by a significance value of less than 0.05, which is less than 0.001. It can also be seen that the average pretest score is 4, while the average posttest score is 5.92308 (see Table 1). So, based on the t-test results, this

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means that after attending Geogebra training, there was a significant increase in participants' knowledge regarding the use of GeoGebra.

Table 2. The t-test: paired sample test

Paired Samples Test

		Paired Differences					t	df	Significance	
					95% Confidence Interval of the Difference				**One-Sided p**	**Two-Sided p**
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper				
Pair 1	pretest - postest	-1.92308	1.18754	.32936	-2.64070	-1.20545	-5.839	12	**<.001**	**<.001**

Several obstacles occurred in the implementation of this activity. Initially, Geogebra training activities were planned to be carried out in a hybrid manner, namely online and offline. However, the absence of a suitable time agreement resulted in activities being carried out entirely online. The community service team and the participants have busy schedules, making it challenging to find time slices. This online activity also resulted in participants feeling that interaction was lacking, especially activities in operating computer applications, which would be better if carried out face to face. Apart from that, the busyness of the participants who are teachers means that many of them have not had time to complete the assignments given.

The results of interviews with four participants show that this kind of training is needed for mathematics teachers because they feel that it is beneficial to have applications that can make teaching more accessible and make the learning atmosphere less boring.

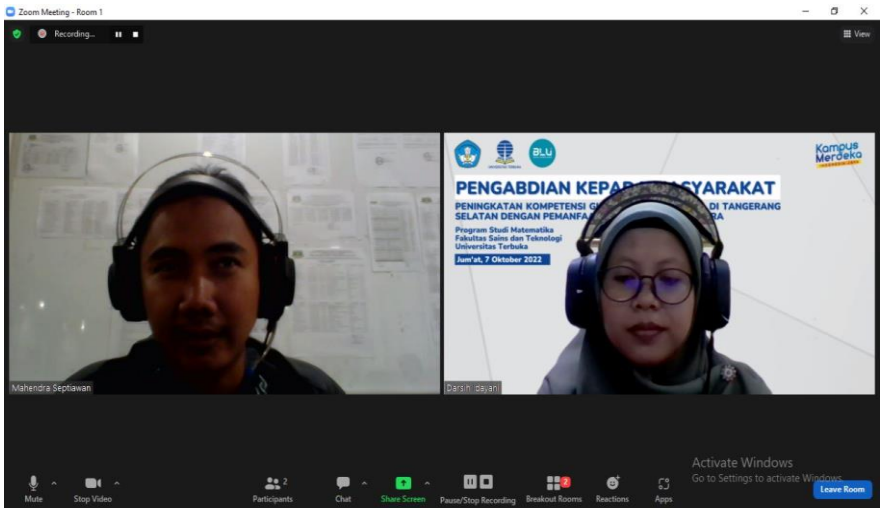

Figure 5. Interview with one of the participants

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CONCLUSION

The conclusions obtained from the implementation of this activity are: (1) GeoGebra can help the high school mathematics teaching process by creating graphic images, flat figures, and spatial statistics. Apart from that, GeoGebra can also be used to solve Calculus problems such as derivatives, integrals, and limits; (2) There is an increase in participants' knowledge regarding the use of GeoGebra; and (3) Training and mentoring activities enable participants to gain new knowledge about GeoGebra software according to their needs in teaching mathematics in high school. The possibility of further development is that GeoGebra training can be continued, especially the use of GeoGebra Classroom, which teachers can use to give interactive assignments to students and monitor student work virtually.

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