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Enhancing High School Mathematics Learning Through Moodle Feature Development

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ABSTRACT

The development of information and communication technology in the 21st century spurs the need for digital learning systems to improve the quality of education. This research aims to develop a Learning Management System (LMS) Moodle with additional features that support mathematics learning at the high school level. The research method used in this research is the research and development (R&D) method, with the model used being the Four-D Model or adapted into a 4-D model. Based on the research results, the features developed include typing mathematical formulas using MathType by Wiris, graph visualization, and GeoGebra-based simulations. The results of the trial show that this additional feature increases the effectiveness of mathematics learning and the efficiency of students' learning time. Developing an LMS with interactive features supports a more dynamic and meaningful learning process.

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1. INTRODUCTION

In the 21st century, the development of science and technology (IPTEK) is rapidly increasing [1]. This rapid progress has an impact on increasing the openness and distribution of information and knowledge from all over the world across the boundaries of place, space, time, and distance [2]. In this digital era, human life will always be related to technology. Specifically, technology is generally a process of seeking added value and benefits from the products produced [3], [4], [5], [6], [7], [8], [9].

The development of information and communication technology directly impacts education [10]. The direct impact can be felt starting from the use of learning media to the learning system (e-learning) itself [11], [12]. By utilizing information and communication technology, development education can reach all levels of society [13]. Therefore, people who are interested in education are required to have an understanding of technology. In

addition, education developers must be able to collaborate with technocrats to digitize education [14]. Digital learning systems that are currently popular in society include LMS (Learning Management System) [15], [16], [17], [18] and learning via YouTube [19], [20], [21], [22].

Some LMS that are currently developing include Moodle [16], [17], [18], [19], Google Classroom [23], [24], [25], Edmodo [26], [27], [28], Canvas [29], Sakai [30], WiZiQ [31], ATutor [32], [33], [34], Schoology [35], [36], [37], and Chamilo [38]. LMS Moodle, Edmodo, and Schoology are among the most popular in terms of customers, active users, and online presence [39]. Moreover, to support its function as a digital learning system, LMS must have strategies, approaches, methods, and techniques that follow the field of study to support learning and training activities systematically. These components are manifested in the form of menus available in the LMS. In addition to the completeness of the menu features, language is necessary to make the LMS user-friendly.

Judging from its features, LMS is very much needed by schools to improve the quality of learning, including schools in the Cirebon area. However, challenges remain. In reality, many schools in the Cirebon area still have not utilized LMS for their learning activities. In addition, some math teachers have difficulty typing formulas and displaying math graphs with the default LMS without modification, thus reducing learning effectiveness. These challenges highlight the need for further development and support for LMS usage.

Some research on the development of Moodle as a learning media has been carried out, such as the development of learning media for Moodle-based PGSD [40], the development of Moodle-based learning media for geometry material [41], and the development of Moodle-based blended learning mathematics media [42]. Interestingly, almost all Moodle development research to support learning is to produce Moodle-based math learning media. Moodle-based learning media in some of these studies can be applied to certain materials and the creation of learning media outside of Moodle, which can then be uploaded to Moodle. No research has developed Moodle features that can be used in learning mathematics in general. For instance, almost every mathematics learning material in high school must display mathematical symbols such as integrals, squares, roots, and other notations. This issue is reinforced by interviews with high school math teachers who stated that it was difficult to learn math using Moodle because even basic things like writing mathematical notation were challenging.

This research is motivated by the need for a more effective LMS in supporting mathematics learning for all materials at the Senior High School (SMA) level. This research mainly focuses on identifying the features high school math teachers need to conduct learning. Then, based on the results of interviews with high school teachers related to constraints and what features are needed for learning mathematics in high school, the researchers will proceed to develop features that can be added to Moodle so that teachers can use it for learning mathematics for all materials in high school. This research also aims to develop Moodle by adding features to Moodle based on the needs of mathematics teachers in doing high school math learning using Moodle.

2. METHOD

This research was conducted in Region III of Cirebon City, Cirebon Regency, Kuningan, Majalengka, and Indramayu. There are eight schools studied, namely MAN 2 Cirebon City, SMA N 1 Sumber, SMA Syarif Hidayatullah, SMA N 1 Dukupuntang, SMA N 1 Kadugede, MAN 3 Kuningan, SMA N 2 Majalengka, and SMA N 1 Sukagumiwang. This study involved 16 mathematics teachers and 40 high school students from 8 schools. Data collection techniques include observation, interviews, documentation, and literature studies. Observations were made by looking at mathematics learning in high school using a Moodle-based LMS. The interview was conducted by asking several questions to 2 mathematics teachers and five students in each school about the obstacles to learning mathematics using Moodle-based LMS and what features are expected to support mathematics learning in high school using Moodle-based LMS. In addition, a literature study was conducted to look for features that might be added to the Moodle-based LMS.

The research method used in this study is the research and development (R&D) method, with the model used being the Four-D Model or adapted into the 4-D model. The flow of activities carried out at each stage of development can be described as follows.

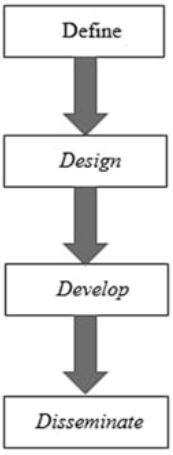

Figure 1. 4-D model

In the first stage, it is Define. In this definition, development needs analysis activities are carried out, product development requirements follow user needs, and research and development models (R&D models) are suitable for product development. At this needs analysis stage, interviews were conducted with 16 mathematics teachers and 40 high school students to record what obstacles in learning mathematics in high school using Moodle-based LMS and what features are needed to support mathematics learning in high school using Moodle-based LMS.

The second stage, namely Design, at this stage is the design of Moodle-based LMS development by adding features according to the needs analysis results. At this design stage, it will also be determined what features will be added and can be added to the Moodle-based LMS to support mathematics learning.

After designing, the next Stage is Develop. At this stage, development is carried out on Moodle-based LMS. At this stage, additional features are included in Moodle to support

math learning. At this stage, whether the added features can run well in a Moodle-based LMS is also checked.

After it is confirmed that the added features can be used properly, the next Stage is Disseminate. At this stage, dissemination was carried out at the high school mathematics teacher forum in Cirebon. At this stage, the researcher introduced and distributed a Moodle-based LMS for free, adding features that support mathematics learning in high school to mathematics teachers. The Moodle-based LMS researchers have developed is expected to make it easier for teachers to learn mathematics in high school.

3. RESULTS AND DISCUSSION

This study developed the Moodle LMS by adding special features to support mathematics learning at the Senior High School (SMA) level. The features added to the Moodle LMS are features for typing mathematical formulas using MathType by Wiris and graphic visualization and simulation features with GeoGebra. The results of this study are discussed in detail in two subsections. The first is about the results of the Define and Design stages. The next is about the results of the develop and disseminate stages. The first section discusses the results of interviews with teachers and students regarding their needs in mathematics learning (Define stage). The results of observations on the Moodle application system are also discussed to see what features are available and what plugins can be integrated with Moodle (Define stage). This section also discusses what features will be integrated into Moodle according to the needs of students and teachers (Design Stage). Furthermore, the second section discusses how these features are implemented in Moodle and checks whether they run well from the installation process to their implementation in typing and displaying images (Develop stage). Finally, this section also discusses how Moodle is distributed to the mathematics community to be helpful in mathematics learning (Disseminate stage).

3.1. The Need for Mathematics Learning Features and Their Integration in Moodle

In the process of determining the Moodle features needed in Mathematics learning at the needs analysis stage, interviews were conducted with mathematics teachers at MAN 2 Kota Cirebon, SMA N 1 Sumber, SMA Syarif Hidayatullah, SMA N 1 Dukupuntang, SMAN 1 Kadugede, MAN 3 Kuningan, SMA N 2 Majalengka, and SMA N 1 Sukagumiwang. Of the 16 mathematics teachers and 40 high school students who visited, teachers and students had difficulty typing mathematical formulas and displaying mathematical graphs with the default LMS without modification. Furthermore, based on the study results and direct observation of the Moodle application system, it was obtained that Moodle does not explicitly provide an interface to handle mathematics learning activities. However, third-party features in the form of plugins can complement these functions, namely the MathType, GeoGebra, LaTeX Source, DragMath, STACK, and ChemType plugins. To meet the needs of students and teachers, the MathType feature by Wiris is used to overcome the problem of typing mathematical formulas, while the GeoGebra feature is used to overcome the problem of graphic visualization and simulation. The following is a description of these features.

MathType by Wiris is a feature available as a plugin in Moodle, but it is not active by default. The Moodle administrator must install and activate this plugin to activate it. Once activated, users can type mathematical notation quickly. The advantage of this feature is that it allows the presentation of mathematical material interactively and helps students understand concepts better. Its use also increases the efficiency of learning time because the material can be presented more clearly and quickly. However, the disadvantage is that this plugin's installation and activation process requires an active role from the Moodle administrator, which can be an obstacle if there is no adequate technical support.

GeoGebra is also available as a plugin in Moodle that allows users to include GeoGebra activities in Moodle courses. Like MathType by Wiris, the GeoGebra plugin is not active by default and requires installation and activation by the Moodle administrator. Once activated, users can create and display mathematical graphs and simulations. The advantage of this feature is that it allows for visual and interactive presentation of mathematical materials, thus helping students understand concepts better. However, the disadvantage is that it requires a stable internet connection to function optimally, and there is an initial learning curve for teachers and students to understand how to use it effectively.

3.2. LMS Moodle with developed features and its dissemination

In this subsection, we will discuss the installation of the features that have been identified and developed, as well as how to use them. In addition, we will also explain the dissemination of LMS Moodle with developed features in the mathematics learning process.

3.2.1. Feature Installation and How to Use It

After identifying the features needed for mathematics learning, these features are installed on the Moodle LMS. The process of installing these features involves several steps, as follows.

MathType by Wiris Installation:

a) Plugin Installation: Moodle administrators need to download the MathType by Wiris plugin from the official website or Moodle plugin repository. Once downloaded, the plugin is installed through the Moodle admin interface.
b) Plugin Activation: After installation, the MathType by Wiris plugin must be activated through the Moodle admin settings. This activation allows users to start using the math formula typing feature in various activities in Moodle.
c) Plugin Configuration: Administrators can perform additional configurations to customize the plugin's functionality according to user needs. This includes setting the appearance and accessibility of the features within the course.

Based on the results of teacher interviews, the MathType feature in Moodle is very much needed because teachers are often confused about writing mathematical notation when creating materials and questions in Moodle-based LMS. After installing MathType

by Wiris in Moodle, the MathType feature can appear automatically when teachers or users create materials, as shown in Figure 2.

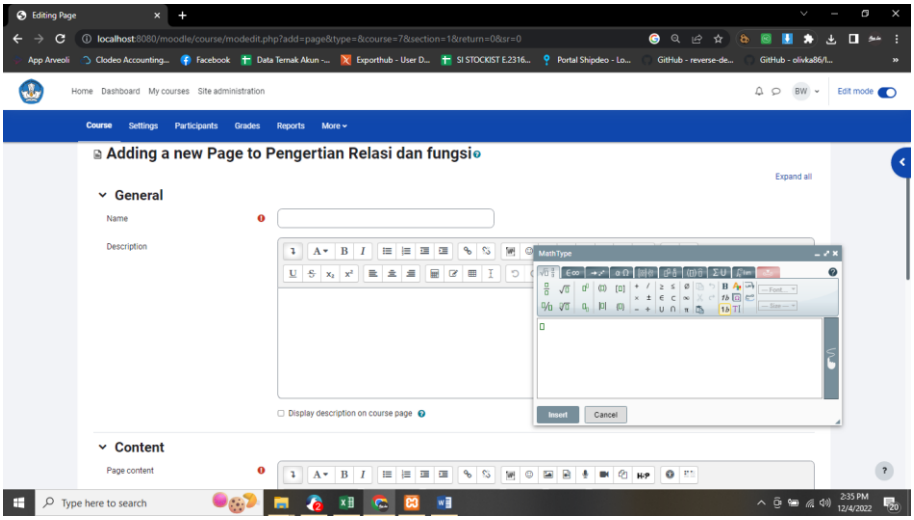

Figure 2. MathType features when active

Figure 2 shows that after installing MathType by Wiris on Moodle, the MathType feature can appear automatically on the toolbar. This makes it easier for users to use it when writing mathematical notations. Users, both teachers and students, can write mathematical notations in the LMS by clicking or selecting notations through the MathType feature. The MathType feature has complete mathematical notations such as root notation, exponent, integral, division, sigma, and other mathematical notations, as seen in Figure 3.

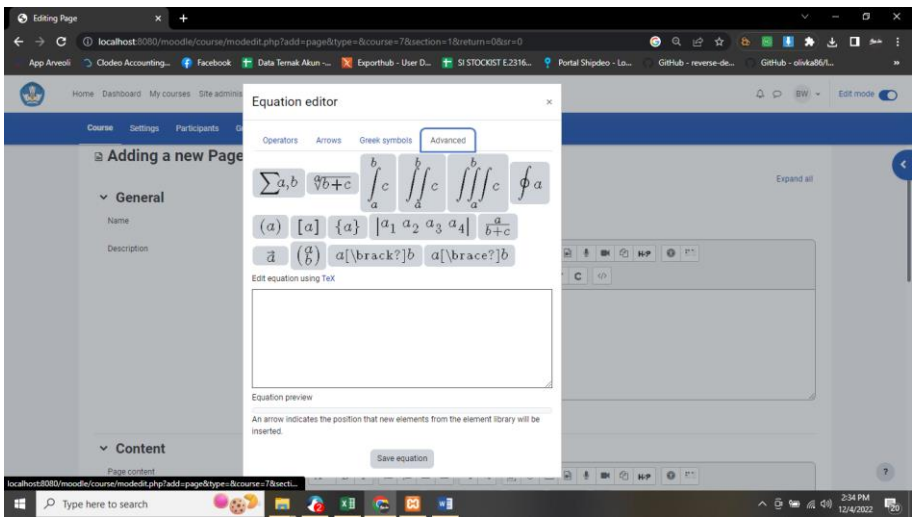

Figure 3. Mathematical notation in MathType Feature

Through this MathType feature, both teachers and students no longer have difficulty learning mathematics because the mathematical notation needed to learn mathematics can be written easily in the LMS. The following is an example of the use of

MathType by teachers in learning mathematics for the material of the original area (Domain) and the resulting area (Range).

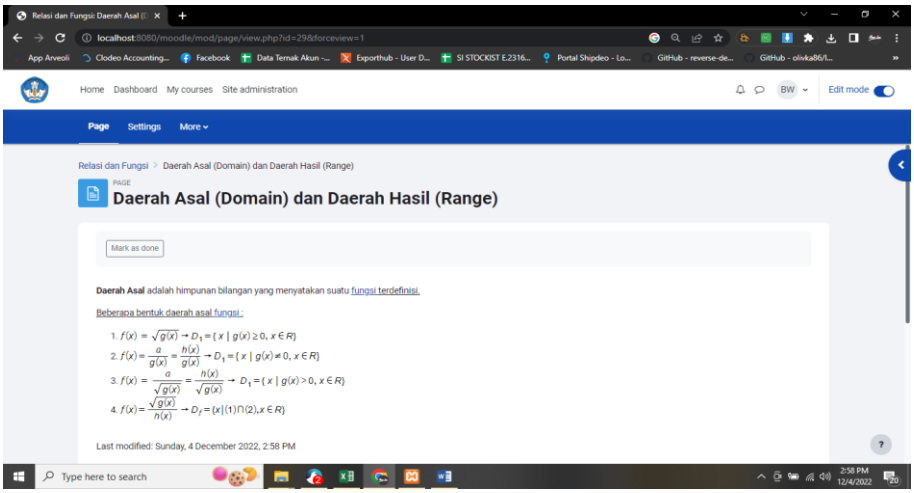

Figure 4. Domain and Range material in LMS

GeoGebra Installation:

a) Plugin Installation: The Moodle administrator needs to download the GeoGebra plugin from the official website or Moodle plugin repository. The plugin is then installed through the Moodle admin interface.

b) Plugin Activation: The GeoGebra plugin must be activated through the Moodle admin settings after installation. This activation allows users to create and display graphs and mathematical simulations in various activities in Moodle.

c) Plugin Configuration: The administrator can perform additional configurations to customize the plugin's functionality according to the user's needs. This includes setting the appearance and accessibility of features within the course.

In learning mathematics, especially the function material, it is necessary to display a function graph. Based on the results of interviews with mathematics teachers, it was obtained that teachers often find it challenging to display function graphs in the LMS. After installing the Geogebra application on Moodle, users or teachers can easily display function graphs on the LMS. The installation of Geogebra is added to the Activity or Resource feature in Moodle. Therefore, users or teachers can display function graphs by selecting the Geogebra application on Moodle's Activity or Resource menu, as shown in Figure 5.

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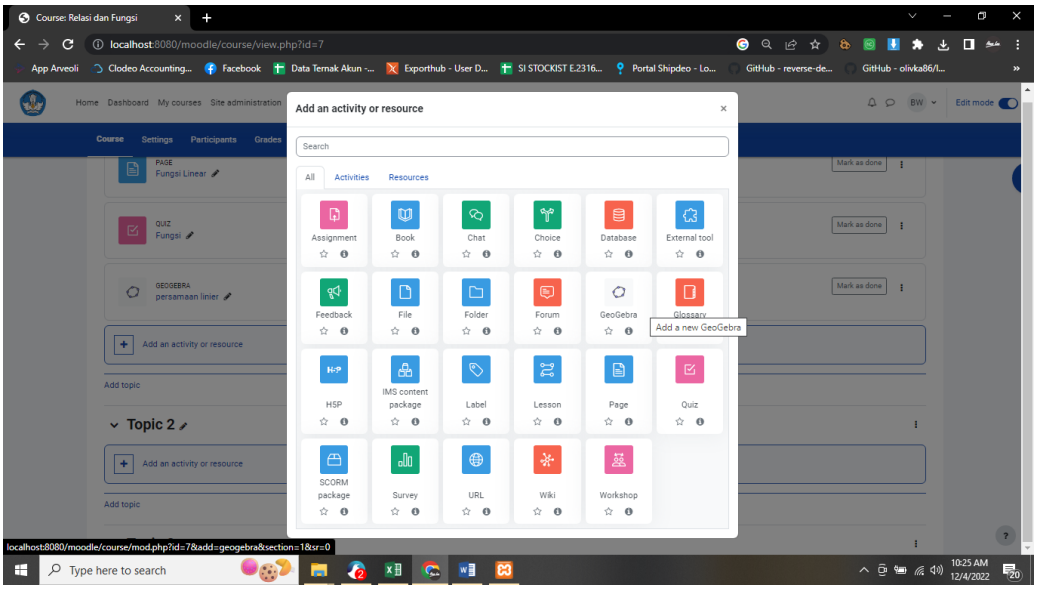

Figure 5. Geogebra application in the Activity or Resource menu in Moodle

By adding the Geogebra application to Moodle, teachers or users can easily create function graphs by selecting the Geogebra application in the activity and resource menu. Then, teachers can write the function notation that will be graphed in the Geogebra Application. Then, the Geogebra Application will display a function graph, as shown in Figure 6.

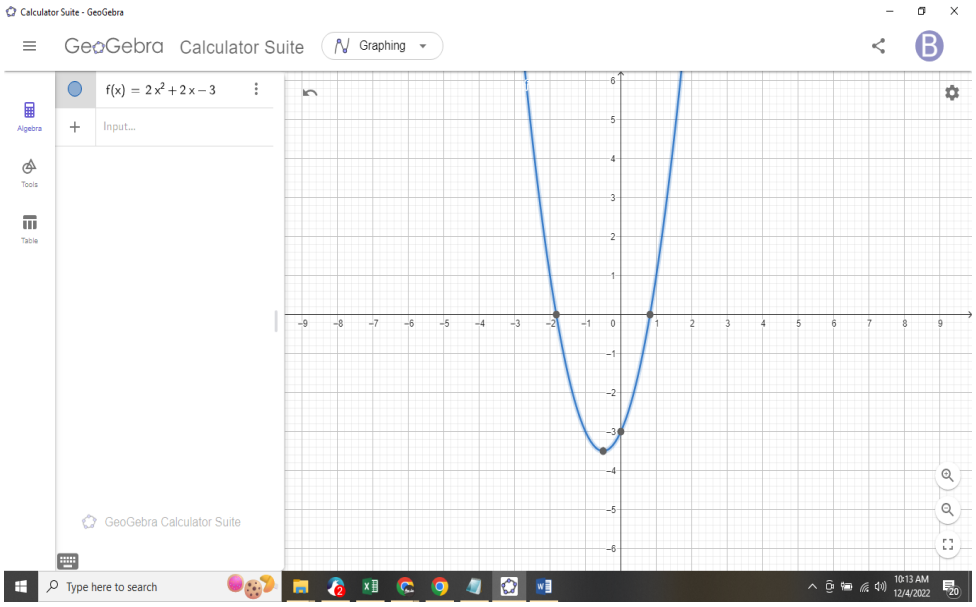

Figure 6. Graph image of the function $f(x) = x^2 + 2x - 3$ in the Geogebra application

After creating a function graph in the Geogebra application, the teacher can save the graph file and display it in Moodle, as shown in Figure 7.

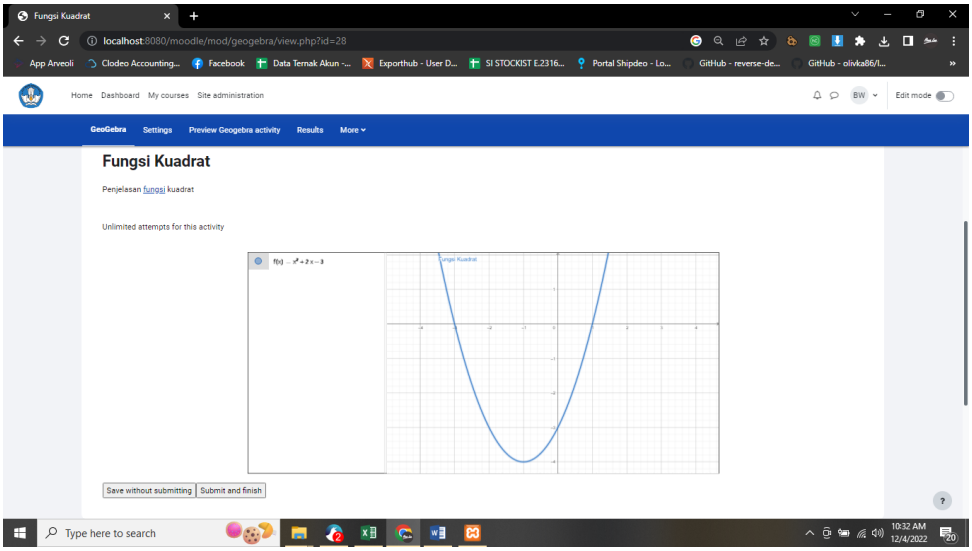

Figure 7. Function in Moodle

Installing Geogebra on Moodle can make it easier for teachers to display graphs and create graphs of a function. Displaying function graphs is very much needed in learning mathematics, especially the material of relations and functions. Installing Geogebra on this LMS will make it very easy for teachers to conduct mathematics learning, especially the material of relations and functions online through Moodle-based LMS.

3.2.2. Dissemination of LMS Moodle with developed features in the mathematics learning process

After MathType by Wiris and GeoGebra features are installed and activated, a guide to using these features is provided for teachers and students to make optimal use of the LMS. Using MathType by Wiris and GeoGebra features allows teachers to present materials more interactively and helps students understand mathematical concepts better.

Teachers are given training on using MathType by Wiris to enter mathematical formulas and GeoGebra to create and display graphs and simulations. This guide and training aim to ensure that users can use these features effectively and efficiently in learning. Feedback from teachers and students also showed that they felt more helped by these features, which made learning more dynamic and engaging.

4. CONCLUSION

This study successfully developed the Moodle LMS by adding special features to support mathematics learning at the Senior High School (SMA) level. The results of the analysis of the needs of mathematics learning features and the analysis of the Moodle system to identify available features revealed the MathType by Wiris feature, GeoGebra feature, LaTeX Source feature, DragMath feature, STACK feature, and ChemType feature related to mathematics learning.

Of these features, MathType by Wiris was chosen for typing mathematical formulas, while GeoGebra was chosen for graphic visualization and simulation. The

selection was based on interviews with teachers and high school students in Cirebon after they demonstrated it using relation and function materials. MathType by Wiris and GeoGebra, once installed and activated, allows the presentation of mathematics material interactively and visually, thus helping students understand the concept better. However, these features also have disadvantages, such as the need for an active role from the Moodle administrator for installation and activation and dependence on a stable internet connection.

The measurement results show that these features increase the effectiveness of mathematics learning and the efficiency of students' learning time. Using MathType by Wiris and GeoGebra features allows teachers to present materials more interactively and helps students understand mathematical concepts better. Feedback from teachers and students also shows that they feel more helped by these features, which make learning more dynamic and engaging.

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