Desmos as a Bridge in Learning Functions in Indonesia Secondary Level: A Literature Review

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Abstract. The use of technology in the pandemic era requires teachers to look for various learning alternatives that are applied so that learning objectives are still achieved. However, learning mathematics online makes it more challenging to comprehend the material because it appears to be more abstract. One of the internet tools that seems promising for assisting students in learning mathematics is Desmos. This article looks into the Desmos features that can help with learning functions in mathematics learning. A descriptive research method was adopted to ascertain the potential of Desmos related to the topic of the functions. The findings show that the Desmos elements and features help the students understand and see the relationship between what is being questioned with the picture or situation provided by Desmos. Representation images of the questions given by Desmos enhance students' curiosity to understand more the meaning of symbols and the relation among functions, and finally, they will be able to solve the problem easily.

Keywords: Desmos · Functions · Secondary education

1 Introduction

During this pandemic due to COVID-19, online learning is required from various levels of education [1]. For more than two years, teachers have expected students to be more independent in their learning, which has prevented pupils from losing what they had learned without additional teacher assistance. Even though it is done online, the teachers have sought to employ a variety of platforms to generate effective learning for the students. The goal is for children to learn mathematics accurately and enough to follow the advancement of science and technology and use it in their daily lives.

On the other hand, learning mathematics online is challenging because it is an abstract subject for higher and lower-level students. Students are expected to master various skills to solve arithmetic issues, including the ability to recall, comprehend, interpret information, understand the meaning of symbols and manipulate them, abstract, generalize, reason, and solve problems. One of the subjects that high school students are struggling with is functions. The challenge is the inability to use abbreviations or technical terms when discussing functions and relations [2]. As a result of students' constant associations

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with numbers and formulas, many types of function modeling in real life frequently do not appear like functions.

One method for lowering the function's abstractness that frequently happens in daily life but is rarely understood by students is to use Desmos. Through the web, iOS, and Android applications, the Desmos platform provides various mathematical tools, digital math activities, and courses to support students in improving their higher order thinking skill happily [3]. To enable students to complete real-world arithmetic tasks, teachers can use Desmos to enhance the quality of mathematics teaching and learning. This article seeks to explore the characteristics of Desmos in learning related to the topic of function based on its potential.

2 Method

The method used is a descriptive research method. The author reviewed recent articles related to Desmos and analyzed the potential that can be used in teaching material related to functions. First, the author collected articles with the keywords Desmos, function, and secondary school math problems in the last five years. Second, the author categorized Desmos activities that were carried out by previous research. Third, the author proposed Desmos activities related to functions.

3 Result and Discussion

The results demonstrate that Desmos's aspects and characteristics aid students in understanding and appreciating the connection between the subject of the inquiry and the illustration or scenario given by Desmos.

The project from Erasmus + Programme shows the mathematical concepts related to horizontal and vertical lines, absolute value, linear function, and circle using Desmos [4]. The class has the objective to help students understand the concept of the equation and be able to predict their graphical representation by experimenting on an online Cartesian plane. Students were required to produce some shapes by applying different functions while demonstrating class activity using Desmos. The example below shows the class activity in shaping Spongebob's house that needs students' creativity in manipulating the graph to create curves (Fig. 1).

The most common activity in using Desmos for function topics is drawing the linear equation $y = mx + c$. It shows that when students click the play button after putting the function into the command bar, the complete picture will be in the form of a video format that helps students understand the equation easily [4]. Some authors in the Erasmus + project also challenge their students to create their own names after analyzing and exploring the function given to make an alphabetic letter [3] (Fig. 2).

At the end of the class activity, the students will find out all the functions to create the alphabetic letter, as shown in Fig. 3 below.

This kind of activity helps students see the line variation in the graph and concludes that the line has different slopes, and then the direction of the lines changes [5].

In addition, a game challenge was created in the trigonometric function topic, called Catch All the Stars, using Desmos [6]. By exploring the game, students will develop

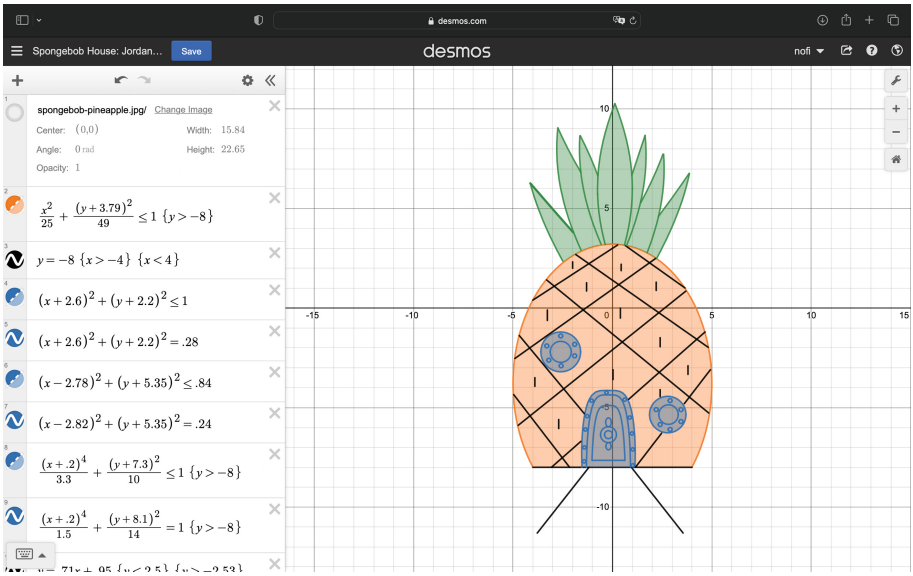

Fig. 1. Spongebob's House in Desmos

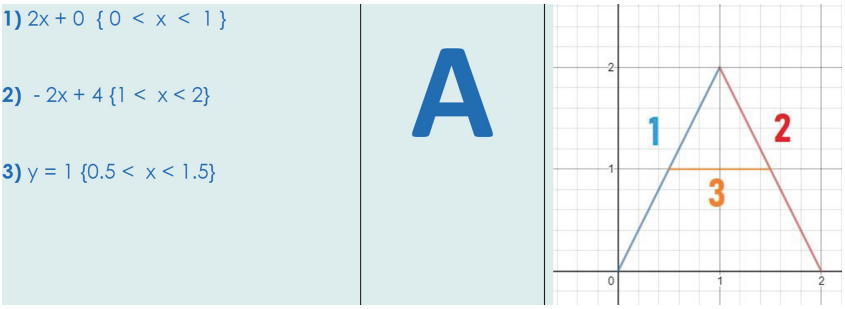

Fig. 2. Letter in Desmos

trigonometric function graphs. Even though those activities mentioned above take time in preparation and implementation, we could provide meaningful learning from the students and enhance their creativity and critical thinking.

Students are curious to learn more about the significance of symbols and the relationships between their many roles is piqued by the analogy of the image used by Desmos to interpret the issue. As a result, they will be better able to solve the problem.

Figure 4 shows that Desmos analogizes the basic concept of function to an illustration of a working machine [7]. Through the animation, students are asked to guess the rule from the input (number 15), which is processed into output (number 5). When the students can give simple explanations and give a reason, then the students are able to reach two indicators of critical thinking skills of FRISCO, which are Focus and Reason

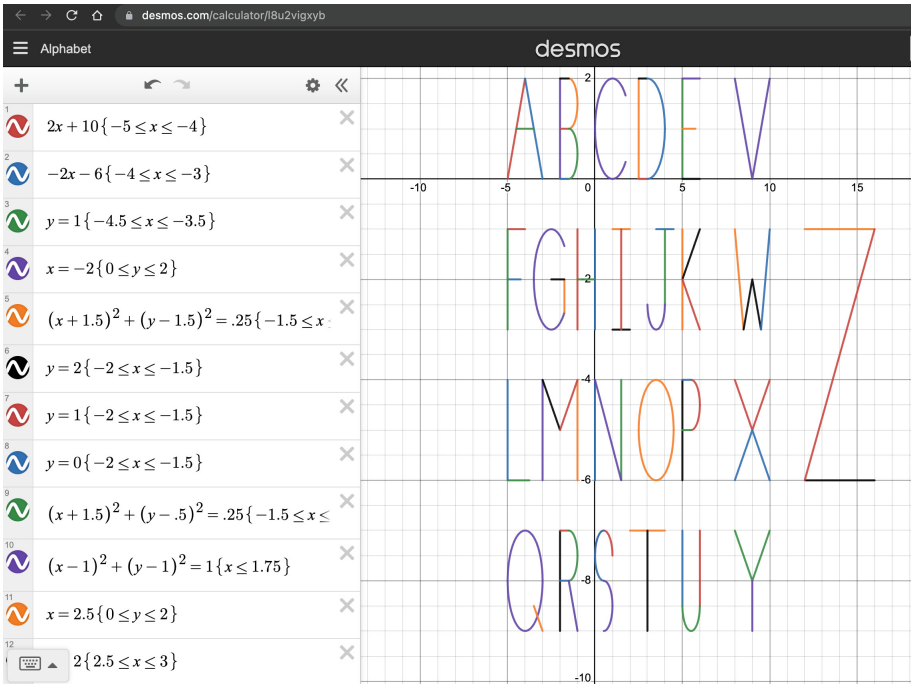

Fig. 3. Alphabetic in Desmos

[8]. This visualization like this should be the key to success in the understanding process because it can provide a learning experience that triggers students' critical thinking [9].

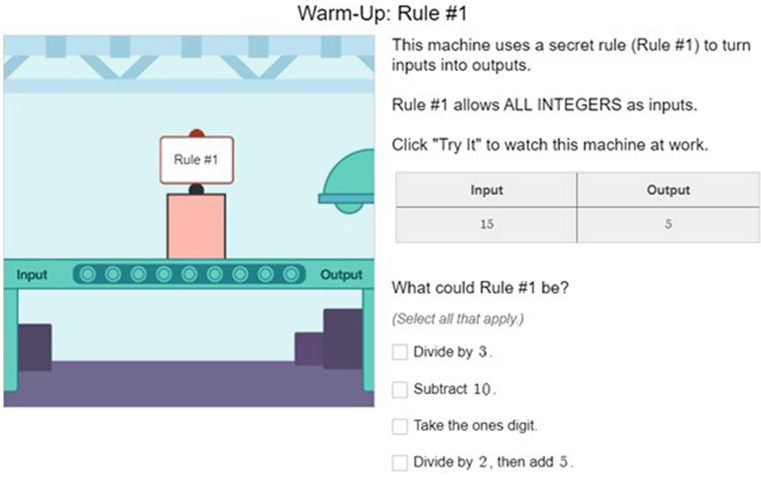

Fig. 4. First Stage of Guess My Lure on Desmos

In the second stage, students are invited to experiment by determining their input (in the form of numbers) to verify whether their answers in the first stage are correct or not. The flow of activities like this runs until the eighth stage, with four rules that they must find. Students are given the space to build their understanding through the experiments they do [10]. Therefore, when the students can conclude (Inference), use the information given (Situation), provide a further explanation (Clarity), and set strategy and tactics (Overview), then they reach all indicators of critical thinking skill called FRISCO [8].

Students are not immediately defined as a function after the discovery of Rule #1. They must complete the activity stages until they find Rule #4. Of course, the achievement of experiences like this cannot be separated from the quality of the form of representation of the concept itself, where representation has a significant role in learning mathematics [11]. In other words, in virtual learning, presentations in illustrative representations (images of machine processes), forms of linguistic representations (how to explore students' mindsets), and forms of manipulative representations (virtual experiments) are the key to bridging the process from realistic representations to symbolic representations [11].

In the ninth stage, students are presented with a table that Rule #1, Rule #2, and Rule #3 are functions, but Rule #4 is not a function. At this stage, for the first time, (Fig. 5) the term function is conveyed by formulating a definition through the question, "What do you think makes a rule a function?"

At this stage, students are given a summary of activities in a table showing each rule. A table is a form of evidence that they need to analyze before concluding. In the thinking process, students will experience a phase where they must distinguish facts from assumptions and continuously re-examine the assumptions and arguments behind their beliefs and actions until they finally conclude (Fig. 5). They then pour the conclusions into answers to the questions above. In other words, when students experience a series of thought processes, they are in a critical thinking process [9].

Based on the discussion from the previous studies and implications within this study, teachers need to know the importance of ICT, which can enhance students' creativity

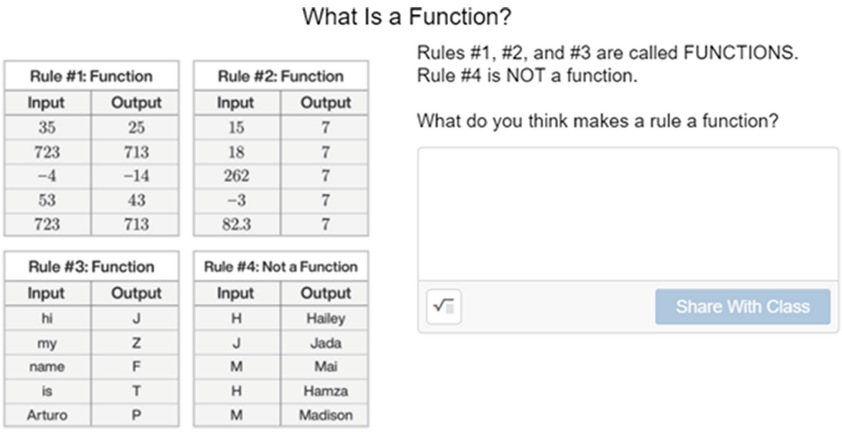

Fig. 5. Ninth Stage of Guess My Rule Activity

and critical thinking skill. The usage of ICT in mathematics class should be expanded upon, examined deeper, and adjusted to the changing demands of today's students, not just during the pandemic.

4 Conclusion

Since the COVID-19 pandemic, a new learning system in schools has been called online learning. Consequently, teachers must be creative in developing virtual learning activities or using activities already available on the internet. Applications such as Desmos can be an alternative technology that teachers can use to create interactive virtual classrooms. Visualizing the function concept in the "Guess My Rule" activity can help students construct their understanding of the function concept. However, Desmos does not have a chatroom feature so that in its implementation teachers can use highly interactive activities or can use other applications that can accommodate direct discussion rooms such as online meeting applications. In addition, this paper is only limited to reviewing activities related to the introduction of functions. Therefore, the authors recommend further research on developing activities on Desmos or reviewing activities that are already available on Desmos regarding deeper function concepts such as linear functions, quadratic functions, and the like. In the end, students can have a complete meaning, not only on the surface.

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