

# Winplot Application for the Development of Constructivism-Based Mathematics Learning at PGRI 24 High School Jakarta

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## ABSTRACT

*Mathematics has many abstract concepts that are hard to understand by students. Learning media as an intermediary play an important role in interpreting difficult materials to them. One of the learning media used by teachers related to mathematics equations and functions is Winplot. This community service is implemented at SMA PGRI 24 Jakarta in 2018. The purposes of this activity are (1) assisting teachers to build learning materials based on constructivism, (2) Assisting teachers to create teaching materials that are interesting and easy to understand by students, and (3) Improving the quality of schools through learning media implementation in teaching-learning activities, such as Winplot. The training method consists of several stages as follows (1) observation and interview, (2) presentation and discussion, and (3) evaluation. The results show that (1) teachers can improve their teaching performances based on constructivism, (2) teachers can develop learning materials which is easy to understand as well as can create an interesting learning atmosphere, especially in subjects related to quadratic equations and functions, (3) the quality of learning and teaching activities in school increases.*

**Keywords:** *Constructivism, Learning Media, Winplot*

## 1. INTRODUCTION

Good quality of education will provide foundation to the creation of reliable and competent human resources. So, they will be able to develop their potentials possessed for the nation's development. And one way to achieve the goal is by implementing formal education, both in schools and communities. Schools as one of the institutions that organize formal education have a very important role in realizing the national education purposes in the teaching and learning process.

Learning is the process of preparing the information and structuring the environment in the process of scientific discovery. The environment does not only mean a place to study, but also include the methods, media, and instruments needed to convey information and guide students to learn. The information and environment are flexible, depending on the learning goals to be achieved.

Currently, there are a variety of approaches in education, especially in the learning process. One of them is constructivism. Constructivism is chosen because it can increase students' enthusiasm to solve given problems. It is known that the most common way of learning is a traditional classroom. Teachers deliver knowledge, while students sit in silence. This learning method often lead to students' boredom. Besides, a teacher should pay attention to the students' initial ability in order to convey appropriate mathematical concepts successfully.

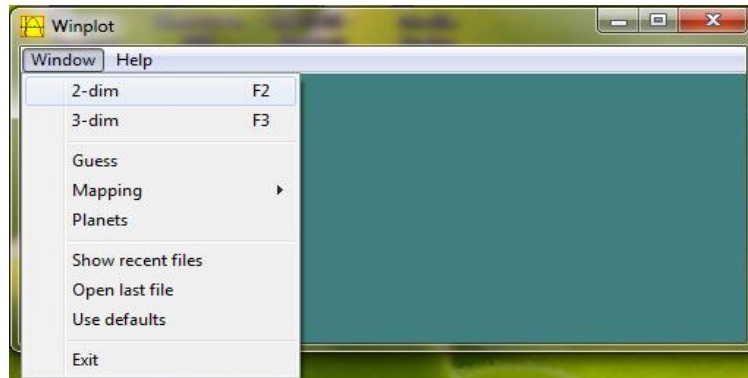
Construction means building. In the context of educational philosophy, constructivism is an effort to uphold the order of modern cultural life (**Budyastuti & Fauziati, 2021**). Constructivism is the thinking basis of contextual learning stating that knowledge is built by humans little by little, and the results are expanded through a limited and non-instant context (**Novita, Muzakkir, & Rapi, 2020**). Thus, by employing constructivism, knowledge will be formed or developed in the students' mind when they try to organize their new experience based on their initial cognitive framework.

Mathematics is the science of numbers, including the relationship and the operational procedures in solving problems. Mathematics is considered a difficult subject for students, because of its abstract characteristics. Mathematics bears an abstract concept or idea whose reasoning is carried out in an axiomatic deductive way (**Pinahayu, 2017**). Learning advance mathematical concepts cannot only be explained by definition, but also require examples related to the subject matter. And one way is using learning media (**Pinahayu, 2017**).

Learning media can be defined as both physical and non-physical tools used by teachers in conveying materials to students to be more effective and efficient (**Puspitarini & Hanif, 2019**). Learning media is one of the success factors of the learning process that has to be considered in all subject (**Prasetyo, Kristiyanto, & Doewes, 2019**). Media play an intermediary in learning process for explaining unclear and difficult subject materials. It can help teacher deliver knowledge that is difficult to explain verbally. Even abstract materials can be concretized through learning media (Lestari). Therefore, the existence of the media plays an important role in the mathematics learning process which has an abstract object of study, especially in learning of quadratic equations and functions.

Education is a conscious effort to develop the potential of qualified human resources who are able to master and evolve science and technology. Technology is not only a goal, but can also be used as a tool in learning practice. Thus, technology has two-side role, namely as a result of the mastery of science that develops technology, as well as a tool in the mastery of science (**Afgani, 2011**). Computers have played a major role in bringing new technologies in various areas of life. In education field, computers are not only as an educational result, but also used as learning resources and media (**Afgani, 2011**).

There are many softwares that have been specially created to help students in learning mathematics, including Maple, Matlab, Winplot, Wingeom, Winstat, Winmat, Octave, etc (**Maryanti and Qadriah, 2019**). Winplot is one of the free mathematical softwares which developed by Richard Parris of the Phillips Exeter Academy, New Hampshire (**Sunyono, Tania, & Saputra, 2016**). Winplot is presented as an alternative way to easily plot mathematical equations especially wave functions (**Saputra et al., 2015**). This software can be used to learn mathematics in middle and high schools. To exemplify, Winplot can assist students in understanding a quadratic equation. It used as a tool for drawing curves, so learners can visualize the value of a function and interpret the mathematical models from real problems more easily as shown in figure 1.



**Figure 1. Winplot Display Screen**

One result of community services showed that teachers could maximize the use of learning media to improve the quality of learning practices in the classroom (**Pinahayu and Marfu'ah, 2020**). In addition, the research that conducted by (**Sunyono *et al.*, 2016**) found that students' learning exercise using Winplot was an effective computer-based learning strategy to counter several student misconceptions about orbitals and quantum numbers. Furthermore, the teachers are encouraged to create various strategies and ideas in teaching and learning mathematics by using technology (**Selvi, 2015**).

Observation result indicated that teachers at PGRI 24 Jakarta High did not use supporting learning media in teaching mathematics, especially material related to quadratic equations and quadratic functions. Besides, teachers had difficulties to create interesting teaching materials and support constructivism-based learning in the classroom. Therefore, it is necessary to conduct a socialization about applying media in learning, such as Winplot which has an impact on the development of teachers' creativity and innovation in the learning process.

Based on the analysis, the team found several problems faced by SMA PGRI 24 Jakarta and SMP PGRI 30 Jakarta, as follows:

1. Teachers experienced difficulties to design learning practice based on constructivism.
2. Teachers had problems in creating learning materials that were interesting and easy to understand. So, it could help students to think and comprehend in a better way, especially about materials related to quadratic equations and functions.

The aims of these activities are:

1. Assisting teachers to design learning practice based on constructivism.
2. Assisting teachers to develop learning materials that can make it easier to better understand material related to quadratic equations and functions.
3. Improving the quality of schools through the design of learning materials using Winplot.

## **2. METHOD**

The community service was conducted at SMA PGRI 24 Jakarta in 2018. The methods of this activity consisted of several steps as follows:

1. Observation and Interview

The team came to the location to gather data and information. This step was carried out twice, namely before and during the implementation program. This stage was useful to identify the learning conditions at SMA PGRI 24 Jakarta, as well as determined the solutions that would be offered to solve existing problems.

Observation was very important to realize the success of community service program themselves.

## 2. Presentation and Discussion

The teachers' training was delivered by a resourceful person consisting presentation, which was followed by a Question and Answer (Q&A) session. The simulation was then carried out.

## 3. Evaluation

Following the completion of the program, the team evaluated the results to analyze if the delivered material was successfully conveyed to the participants (**Pinahayu dan Marfuah, 2020**).

### 3. RESULT AND DISCUSSION

The community service program was conducted by three people from Indraprasta PGRI University. Based on previous observations, the training was held at SMA 24 PGRI Jakarta. One of the reasons was teachers were still not optimal in utilizing math learning media in classrooms. Additionally, teachers found it challenging to design learning materials that were related to a quadratic equation and function subject employing media. The ability of teachers to use information technology in the classroom will have a significant impact on the growth of the classroom learning process. Because of the enthusiasm of the teachers to participate in the training and the good cooperation between the two parties, this program could be carried out properly. The following is an explanation of the information provided by the community service team on how to use Winplot:

#### Finding the roots of a quadratic equation or the intersection point of a function graph on the X-axis

For example, how to find the root of the equation of the function  $f(x) = x^2 + x - 6$  is as follow.

(1) Sketch the graph of function.

(2) Select One → Zero.

The roots of the equation can be seen one by one by clicking next.

(3) Click misc → data → inspect to find a list of the roots of the equation.

From Figure 2, it can be seen that the equation's roots of the function  $f(x) = x^2 + x - 6$  are  $x = 2$  or  $x = -3$ .

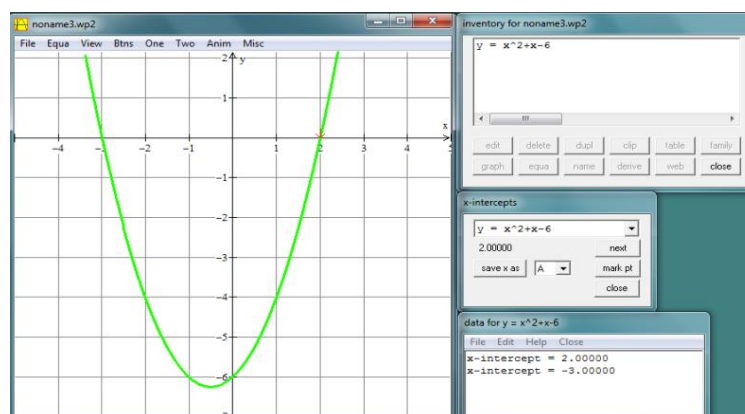
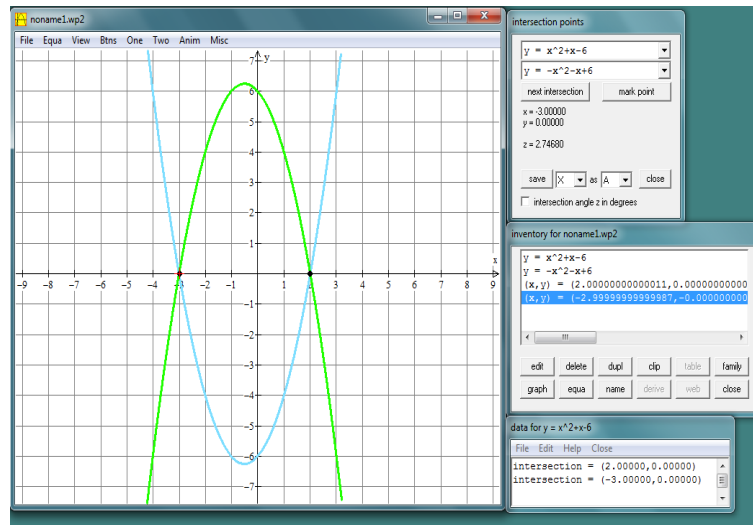


Figure 2. Determines the Roots of a Quadratic Equation

#### Determining the intersection point of two graphs

To exemplify, how to determine the point of intersection of two graphs,  $f(x) = x^2 + x - 6$  and  $g(x) = -x^2 - x + 6$  is as follow.

- (1) Click Two → Intersections to find the point of intersection of two graphs.
- (2) Click Mark Point to mark the intersection points of the two graphs.
- (3) Click Misc → Data → Inspect to find a list of the intersection points.



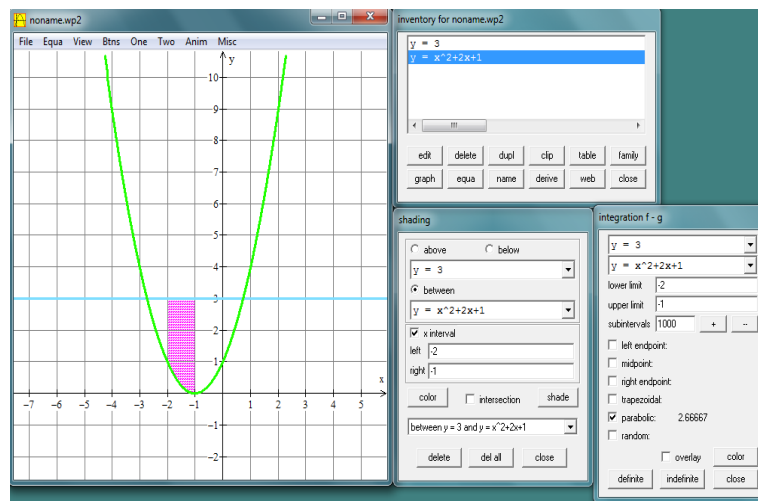
**Figure 3. Determines the Point of Intersection of Two Graphs**

Figure 3 shows that the points of intersection of the two graphs are (2,0) and (-3,0).

**Calculating the area between two function graphs**

- i. For example, how to calculate the area between two graphs  $y = 3$  and  $y = x^2 + 2x + 1$  is as follow.
  1. Select Equa → shade explicit inequalities.
  2. In shading dialog box, click between → intervals (intervals  $-2 \leq x \leq -1$ ) → shade.
  3. To calculate the area between two graphs, select Two → Integrate.

Based on figure 4, it is found that the area between two graphs,  $y = 3$  and  $y = x^2 + 2x + 1$  is 6 2.66667.



**Figure 4. Calculating the Area between Two Graphs  $y = 3$  and  $y = x^2 + 2x + 1$**

- ii. For example, how to calculate the area between two graphs,  $y = 6x - x^2$  and  $y = x^2 - 2x$  is as follow.
  1. Select Equa → shade explicit inequalities.
  2. In shading dialog box, click between → intervals (intervals  $0 \leq x \leq 4$ ) → shade.

The used interval is the value of X-axis at the intersection point of two graphs, namely  $x = 0$  and  $x = 4$ .

3. To calculate the area between two graphs, select Two → Integrate.

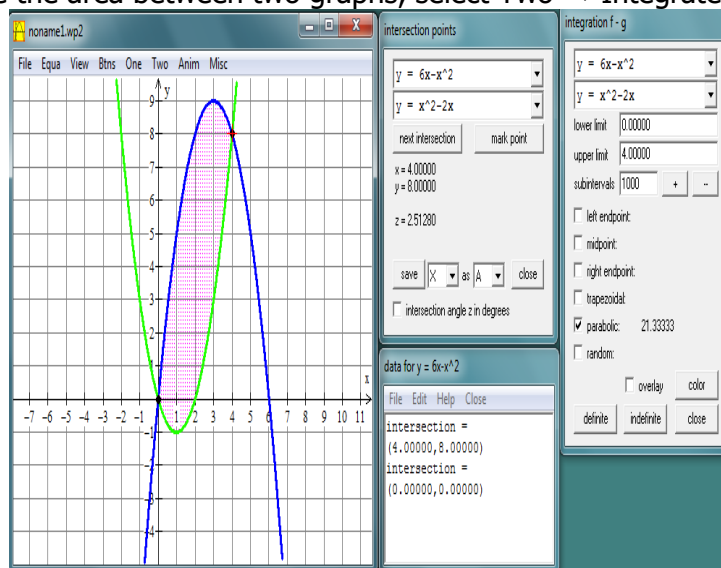


Figure 5. Calculating the Area between Two Graphs  $y = 6x - x^2$  and  $y = x^2 - 2x$

Based on figure 5, it is found that the area between two graphs,  $y = 6x - x^2$  and  $y = x^2 - 2x$  21.33333.

The target of this community service is to teach teachers how to use Winplot and to create learning materials based on constructivism using this application. The following are the outcomes of this activity:

1. The teachers' ability to operate the Winplot application.
2. The teachers' ability to utilize information and communication technology (ICT) to enhance their students' learning performance.
3. The teachers' strengthened capability to produce instructional materials in the classroom.

Previous studies have indicated that using Winplot may aid in learning process. Research conducted by **(Wawan, dkk., 2014)** reported that the STAD learning model with Winplot resulted in better academic achievement than the TAI and direct learning models with PowerPoint. Other research stated that computer assistance using Winplot could enhance learning performances in the equations of straight lines and system of linear equations in two variables **(Ngumar, 2019)**. Applying Winplot encouraged teachers to be more innovative in their delivery of instruction **(Ngumar, 2019)**.

The following are documentation of SMA 24 PGRI Jakarta's community service implementation:

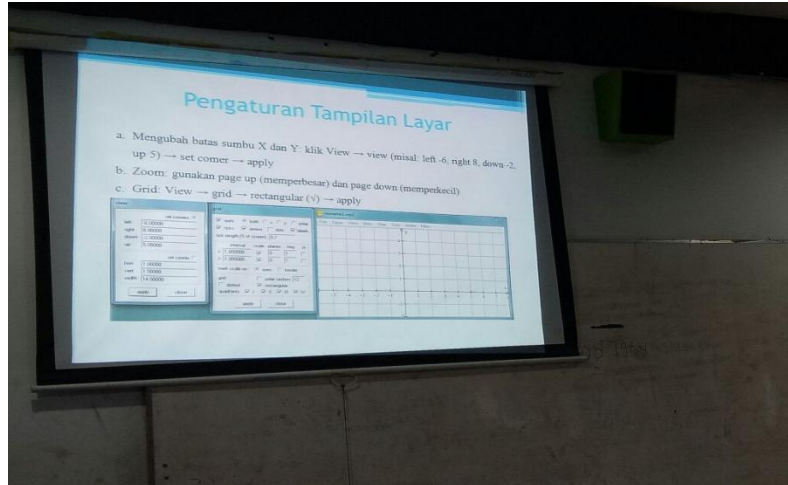


Figure 6. Presentation material at SMA PGRI 24 Jakarta Documentation



Figure 7. Step Evaluation

Figure 6 shows presentation material at SMA PGRI 24 Jakarta documentation. Based on figure 7 the team evaluated the results to analyze if the delivered material was successfully conveyed to the participants. The following are the outcomes of this activity: 1) the teachers' ability to operate the Winplot application, 2) the teachers' ability to utilize information and communication technology (ICT) to enhance their students' learning performance, and 3) the teachers' strengthened capability to produce instructional materials in the classroom.

#### 4. CONCLUSIONS

Several outcomes are obtained as the result of the completed training. Firstly, the program is successful in aiding teachers to strengthen constructivism-based learning in the classroom. Secondly, the teachers are able to produce more entertaining and understandable instructional materials for their students, particularly those involving quadratic equations and functions. Lastly, the effectiveness of learning in schools through the usage of Winplot is improved.

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