The development of online interactive learning media by using google classroom assisted by geogebra software on the quadratic function material

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Abstract. Technological developments are currently entering the industrial revolution 4.0 where everything is digital based. Learning media are tools used by educators in carrying out learning activities. One of the learning media that can be applied in learning mathematics is GeoGebra software. However, the GeoGebra software does not interact between educators and students, so we need a Google Classroom to improve interactive learning that can be combined with GeoGebra Online. The process of developing interactive online learning media using Google Classroom were assisted by GeoGebra software on quadratic function material used the Thiagarajan development model which consisted of four stages, namely define, design, development and dissemination. The results of learning media validation fulfilled the validity criteria with a correlation coefficient based on the validation sheet of 0.92 which is included in the valid category with a very high interpretation. Practical criteria with a percentage of the average value of the user response questionnaire based on a user response questionnaire of 91.75% which is included in the practical category with a good percentage. The effectiveness criteria with the percentage of learning outcomes based on the learning outcomes test was 82.61% which is included in the effective category with a very good percentage. The development of instructional media tested at SMA Muhammadiyah 3 Jember has fulfilled three criteria, namely valid, practical and effective.

1. Introduction
Mathematics is one of subjects studied at school for every level formal education [1]. Mathematics is a basic science that play an important role in human life. In everyday life we would not be separated from mathematics [2]. Especially in the development of science and technology. The development of science and technology was growing rapidly in human life, including in education. At this time, technological developments were entering the fourth industrial revolution known as the 4.0 industrial revolution [3]. The fourth industrial revolution began with the internet revolution in the 90s marked by the emergence of the internet of things where everything was based digitally. In this fourth industrial revolution, everything became unlimited with the use unlimited computing and data power. This was due to the development of the internet and digital technology that was able to influence movement and connectivity between humans and machines. Today's technology is not only used as limited to operating a computer, but it is used as a tool in learning that is expected to be a solution in the learning problems experienced by students and educators.
The renewal of teaching method by students is needed so that the learning process will be more interesting and enjoyable, moreover in the 2013 curriculum educators were required to be able to utilize technology in classroom learning activities. One way was to use learning media [4]. Learning media aimed to use by educators in carrying out learning activities. The use of instructional media in the process of learning mathematics in class could improve student learning outcomes and foster students' interest and motivation in learning mathematics. There were several impacts of the use of instructional media, namely learning more interesting, so that it could motivate students to learn, learning material more clearly, so that students easily reached the learning objectives, educators could combine several learning method and students were more active in learning activities [5]. One of the learning media that could be applied in learning mathematics is GeoGebra software.

GeoGebra is a dynamic software that combine geometry, algebra and calculus. The GeoGebra software was developed to study mathematics and was first taught at school by Markus Hohenwarter from Florida Atlantic University. GeoGebra software was very useful for educators and students as a learning medium that provide visual experiences to students in interacting with mathematical concepts [6]. The GeoGebra software produced a GeoGebra applet in the form of a file with the extension "ggb" which could be accessed on computers that have GeoGebra software installed. After the file was displayed in the geogebra.org account, this learning media could be accessed on all computers connected by the internet. Besides computers, GeoGebra software could be accessed via smartphones. GeoGebra software display consisted of algebraic display and geometric or graphic display that make it possible to make a mathematical object. Mathematical objects could be constructed by entering values into the input bar or using geometry tools from the tool bar and algebraic or numeric representations and graphics would be displayed respectively in algebra view and graphic view [7].

The existence of GeoGebra software could help educators to convey abstract mathematical material to be more easily understood because GeoGebra software could visualize it, besides GeoGebra software was made to train students' creativity and critical power [8]. However, GeoGebra software accessed online there was a lack of interactive learning because there was no interaction between educators and students, so we need an e-learning web to be able to enhance interactive learning that could be combined with GeoGebra Online [9]. There were several e-learning web that could be used, namely Teacher's Room, Quipper, Our Class, Schoology, Edmodo, Google Classroom, and others. Of the several e-learning web available, Google Classroom learning media made it easy for students to interact with online-based educators.

Google Classroom is one of the educational features provided by Google Apps For Education (GAFE) which was released on August 12, 2014. Google Classroom was a free application that allows the creation of classrooms in the real world. Google Classroom functions as a means of distributing tasks, collecting assignments and assessing collected assignments [10]. Google Classroom could help to monitor students to learn. Educators could monitor all student activities during learning through Google Classroom. The interaction between educators and students could be recorded properly. There were several advantages of the use of Google Classroom which has advantages in the fields of communication, interaction, usability, ease of use and overall student satisfaction [11]. In addition, Google Classroom was also easy to use, save time, cloud-based, flexible and free. However, Google Classroom has a weakness that was the absence of external services such as a collection of questions automatically and a space of personal communication between educators and educators to get positive feedback [12]. The display of the Google Classroom researcher account could be seen in Figure 1.
The quadratic function is a compulsory high school mathematics subject for class X which discusses the characteristics of the quadratic function. A quadratic function is a polynomial function of degree 2 which can be written in the general form $f(x) = ax^2 + bx + c$. Here, $a$, $b$, and $c$ represent real numbers where $a \neq 0$. If $a > 0$, then the quadratic function $f(x) = ax^2 + bx + c$, where $a, b, c \in \mathbb{R}$ and $a \neq 0$ open up. Meanwhile, if $a < 0$, then the quadratic function $f(x) = ax^2 + bx + c$ with $a, b, c \in \mathbb{R}$ and $a \neq 0$ open down.

When a graph of the function $f(x) = ax^2 + bx + c$ intersects the X axis, then, $f(x) = 0$, $f(x) = y$ so $y = 0 \iff ax^2 + bx + c = 0 \iff (x - x_1)(x - x_2) = 0$. $x_1$ and $x_2$ are the roots of the quadratic equation. Meanwhile, another way to determine the roots of an equation using a formula is as follows.

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

thus, the coordinates of the intercept are $(x_1, 0)$ dan $(x_2, 0)$. When a graph of the function $f(x) = ax^2 + bx + c$ intersects the Y axis, then, $x = 0$, $f(x) = y$, so $x = 0 \iff a.0^2 + b.0 + c = y \iff c = y$. Thus, the coordinates of the intersection are $(0, c)$.

Based on the general form of the quadratic function $f(x) = ax^2 + bx + c$, with $a, b, c \in \mathbb{R}$ and $a \neq 0$. If $a > 0$, then extreme $y =$ minimum $y$. If $a < 0$, then extreme $y =$ maximum $y$. The extreme point of the parabola of a quadratic function can be determined using the following formula.

$$P(n, m) = P\left(\frac{-b}{2a}, \frac{-D}{4a}\right)$$

where $D = b^2 - 4ac$. If $a > 0$, then it has a minimum turning point. If $a < 0$, then it has a maximum turning point.

There are three conditions of discrimination (D) that play a role in the quadratic function, as follows. If $D > 0$, then the graph $y = f(x)$ intersects the X axis at two points. If $D = 0$, then the graph $y = f(x)$ intersects the X axis at one point. If $D < 0$, then the graph $y = f(x)$ does not intersect the X axis.
2. Research method
The type of research applied was development research (research and development) aimed to produce learning media that will be tested for validity, practicality and effectiveness. The trial was carried out in class X of Muhammadiyah 3 Jember High School with 28 students majoring in Mathematics and Natural Sciences. The learning media development model in this study was the Thiagarajan model. The Thiagarajan model consisted of four stages: the Define stage, the Design stage, the Development stage and the Dissemination stage could be seen in Figure 3 [13].

![Figure 3. Thiagarajan model diagram.](image-url)
3. Results and discussion

Online interactive learning media developed in this study was Google Classroom assisted by GeoGebra software on quadratic function material for SMA / MA grade X. The results of this study were through the process of developing learning media using the Thiagarajan development model which consisted of four stages, namely the define stage, the design stage, the development stage and dissemination stage. The steps taken in this study were as follows.

3.1 Define Stage

At this stage, it sets the goal of making online interactive learning media using Google Classroom assisted by GeoGebra software as a learning aid that can be used both guided and independently by students or users on quadratic function material. To be able to determine learning objectives, five activities are carried out, namely Preliminary Final Analysis, Student Analysis, Concept Analysis, Task Analysis, and Learning Objectives Specifications.

In the preliminary final analysis found the basic problem, namely learning mathematics in the classroom using power point learning media using an LCD projector. Learning by using power points in practice is less efficient, students are less focused when educators explain the material because power point displays the material briefly, so that the power point learning media has no appeal to students and there is no direct interaction with the media.

In the student analysis, it was found that students of SMA Muhammadiyah 3 Jember had the potential to use technology-based facilities. This is evidenced by the fact that most have a smartphone and can access the internet properly. In concept analysis, activities are carried out to analyze the material that will be displayed in learning media, namely the quadratic function which discusses the characteristics of the quadratic function, draws the quadratic function by determining the intersection point, the axis of symmetry, and the turning point.

In the task analysis, activities are carried out to analyze the assignments given to students based on predetermined concepts so that students can achieve minimum competence. In the specification of the learning objectives to be achieved, namely creating learning media that can facilitate the learning process, facilitate interaction between students and educators and create active and fun learning, so that it can help students understand the concepts more easily during learning.

3.2 Design Stage

At this stage was the process of designing instructional media that was compatible with the results of the analysis at Muhammadiyah 3 Jember. In this activity was carried out to choose the right media in presenting learning materials. Researchers chose the Google Classroom media collaborated with GeoGebra online to be developed into a learning medium. Google Classroom was used as an online interactive media between students and educators and the quadratic function material was in GeoGebra online.

Researchers made GeoGebra applets that were done offline using GeoGebra software. In the GeoGebra applet display, there were steps from the quadratic function in the form of a white "Check Box" and the formulas and calculation results in graphics 1. There were four discussions in graphics 1, which were quadratic, discriminant, intersection, and symmetry axis functions and turning point. Meanwhile, in graphic 2 there was a graphic display of the calculation results. The appearance of the GeoGebra applet in the quadratic function could be seen in Figure 4.
3.3 Development Stage

At this stage, the developed learning media produced a draft I that will be validated by experts or validators in order to obtain input and suggestions as well as an assessment of the learning media produced at the design stage. The validator consisted of two lecturers of the Mathematics Department Study Program FKIP Jember University and one mathematics teacher from SMA Muhammadiyah 3 Jember. The validation results of the three validators showed that online interactive learning media using Google Classroom assisted by GeoGebra software on quadratic function material was a learning media with very good category. Based on the results of data analysis showed that the value of the correlation coefficient of the development of learning media was 0.92 which was included in the category of interpretation "Very High". The average value of the results of the learning media validation of each indicator could be seen in Figure 5.

![Figure 4. Geogebra applet display on quadratic function.](image)

![Figure 5. Average value of learning media validation results for every aspect.](image)

After being declared valid, the learning media was tested on the school where the research was held on that was for students of Class X MIPA 2, Muhammadiyah 3 Jember. The results of the implementation of this trial were a test of learning outcomes and user responses to the learning media using Google Classroom assisted by GeoGebra software. Learning outcomes tests were given to measure students’ ability to understand the material that has been taught by educators. The learning achievement test was carried out online where there were 10 questions consisted of 4 multiple choice...
questions, 3 correct or wrong choice questions and 3 short answer questions with 60 minutes of work time and were tested at the end of learning for all students after used the learning media.

Student learning outcomes test scores that scored achieved 75 were 19 out of 23 students. If it was presented with a percentage of students who get a greater or equal value with minimum standard was 82.61%. The percentage results showed that the learning media using Google Classroom assisted by GeoGebra software was effective because ≥80% of students got a greater value or equal to minimum standard. Students who use teaching materials by using GeoGebra software have increased understanding of concepts compared to the students before using teaching materials [14]. Thus, the student learning outcomes with the adoption of Google Classroom were higher than student learning outcomes without using Google Classroom [15]. The value of student learning outcomes could be seen in Figure 6.

![The Value of Student Learning Outcomes](image)

**Figure 6.** Value of student learning outcomes.

The results of analysis on the questionnaire user responses showed that online interactive learning media using Google Classroom assisted by GeoGebra software on quadratic function material was a good learning media with a percentage of the average value of the user’s response questionnaire to learning media by 91.75% which was included in the percentage category "Well". Opinions of students in discussion forums conducted online using Google Classroom could be seen in Figure 7.

![Opinion of students in discussion forums](image)

**Figure 7.** Opinion of students in discussion forums.

Learning media could be said to be practical if the percentage of the average value of user responses in the user response questionnaire showed good or very good categories [16]. Therefore, online
interactive learning media using Google Classroom assisted by GeoGebra software on quadratic function material could be said to be practical.

3.4 Dissemination stage
The dissemination stage was the last stage of development research that produce learning media that were valid, practical and effective through the validation and trial stages. The distribution stage was carried out at Muhammadiyah 3 Jember and social media. Dissemination of instructional media in pilot schools in the form of GeoGebra software learning media design on quadratic function material and guidebooks. In addition, the researchers also provided softcopy of instructional media to mathematics subjects in class X MIPA 2 at Muhammadiyah 3 Jember to be used as teaching material. Distribution of learning media through social media, namely Blogs that can be accessed by users online by visiting the page https://eliesfajri27.blogspot.com/2019/07/pengembangan-media-pembelajaran.html.

Thus, this learning media development research produced online interactive learning media using Google Classroom assisted by GeoGebra software on quadratic function material that meet all three criteria, namely valid, practical and effective. So, this learning media was suitable to be used as learning media.

4. Conclusion
The development of online interactive learning media using Google Classroom assisted by GeoGebra software on quadratic function material has gone through four stages in accordance with the Thiagarajan development model, namely the define stage, the design stage, the development stage and the dissemination stage. The results of the development of online interactive learning media using Google Classroom assisted by GeoGebra software on quadratic function material have fulfilled three criteria, namely valid, practical and effective. Fulfilled the validity criteria with the value of the correlation coefficient on the learning media based on the validation sheet of 0.92 which was included in the category of valid with very high interpretation. Fulfilled the practicality criteria by the percentage of the average value of the user's response questionnaire on instructional media based on a user response questionnaire of 91.75% which was included in the practical category with a good percentage and fulfilled the effectiveness criteria with the percentage of learning outcomes in learning media based on the learning outcomes test of 82, 61% which included in the effective category with a very good percentage.

Acknowledgment
We gratefully acknowledge the support from Mathematics Education Department from Faculty of Teacher Training and Education-University of Jember.

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