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Developing Students' Learning Interest using Math Trail-based Mathematical Modeling with Augmented Reality

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Abstrak. Learning is currently transitioning to digital learning. This encourages teachers to create a learning environment that can support students' learning. The results of PISA 2018 show that students' mathematics learning in Indonesia is not good. This is partly due to the low interest in learning mathematics. Therefore, efforts are needed to increase students' interest in learning mathematics. One of them uses mathematical modeling learning. The purpose of this study was to analyze how the influence of learning mathematical modeling on students' interest in learning. This study used a design research approach focused on the retrospective analysis stage with quantitative and qualitative analysis. The results showed that learning mathematical modeling had a positive effect on students' interest in learning. In addition, students' interest in learning can also be shown when learning takes place. Students participate actively during learning activities, ask questions when needed help, and collaborate with each other. It is hoped that with this research, teachers can use the mathematical modeling learning environment as a learning reference.

Key words: learning interest, mathematical modelling, learning environment

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INTRODUCTION

Learning has changed in the modern era to emphasize digital learning, which includes learning mathematics. Currently, Indonesian mathematics education is still lacking in both quality and infrastructure (OECD, 2021; Santi, 2017). Given the increased development of facilities and infrastructure, the quality of education in Indonesia needs to be immediately improved. Students today become more adept at using technology as a result. Therefore, technology must be used to make learning more engaging.

Many students are happy when mathematics lessons are not in session, while others experience fear (Hadi, 2015). Field data from a Semarang school reveals that there is still little interest in mathematics education. It is crucial for students to be interested in their studies because this can help them comprehend the material being taught and prepare them for college. There are four components of learning interest: attitude, initiative, self-assurance, and motivation (Yeh et al., 2019). When students exhibit positive attitudes, initiative in carrying out learning activities, good confidence in their ability to overcome obstacles, and high motivation while learning, it is said that they have a good interest in learning.

Technology use is becoming more and more significant in math education. To increase students' interest in learning mathematics, the learning environment must be designed to foster that interest. The learning environment is a collection of teaching resources like worksheets, videos, and other media. Students' interest in learning will increase in a positive learning environment. The widely used digital learning media provides a variety of learning opportunities. Learning through augmented reality can be beneficial (Ahsan et al., 2020).

The use of augmented reality in education can be based on the idea that learning can take place whenever and wherever (Bokhove & Drijvers, 2010). Students can use mathematical modeling as a technique to use mathematical models to solve real-world issues (Blum & Ferri, 2009; Kharisudin & Cahyati, 2020; Kurniadi et al., 2020). For students to be able to solve problems in the future, mathematical modeling must be mastered. The math trails activity can be used to teach mathematical modeling. This exercise encourages students to use mathematical modeling to address issues that are present outside of the classroom.

So, learning interest in mathematics must be increased during learning mathematics. teacher must provide the learning environment that support students interest on learning mathematics. The purpose of this study is to ascertain how students' learning interest in mathematics is affected by math trail-based mathematical modeling with Augmented Reality (AR). It is anticipated that this research will be able to add references to the learning environment that will help make math learning even better.

METHODS

Quantitative regression can be used to address research questions. However, a design research approach focuses on retrospective analysis to make the research findings more thorough. The design research methodology was chosen so that questions based on the initial procedure to the final analysis could be addressed. Preliminary design, experimental design, and retrospective analysis make up design research (Prahmana, 2017). The interest in learning mathematics questionnaire's retrospective analysis is the main focus of this study. The odd-numbered semester of the academic year 2022–2023 was used for this study. Students from SMP Semesta Semarang's ninth graders served as the study's subjects.

The stage of research focused on retrospective analysis. Preliminary design was conducted to make the learning environment support the students learning interest. The learning environment consist of worksheet, digital media, and evaluation. After that, the experiment was conducted in 9 grade class SMP Semesta Semarang. After that, retrospective analysis was conducted by using regression test for quantitative and interview for qualitative.

RESULTS AND DISCUSSION

The stages of design research are followed when creating an AR-based math trail-based learning environment for mathematical modeling, from preliminary design to retrospective analysis. In order to increase student interest in learning, preliminary design is being done to create a learning environment for mathematical modeling based on math trails using AR. When deciding how to design the learning environment, reference is made to indicators of student interest in learning. Independent learning allows for the growth of the initiative dimension. The teacher gives students the option to follow instructions if they are independent learners. Therefore, the learning strategy chosen must encourage students to work independently. The media is designed to be run by an individual using the login system displayed in Figure 1.

Figure 1. Login page

Students' own responses display self-doubt. They doubt the accuracy of their responses. The dimensions of less confidence will be affected by this, so that the media can be created to check whether student responses are correct or incorrect. Right is depicted in green in Figure 2 and wrong is depicted in red in one of the student activities.

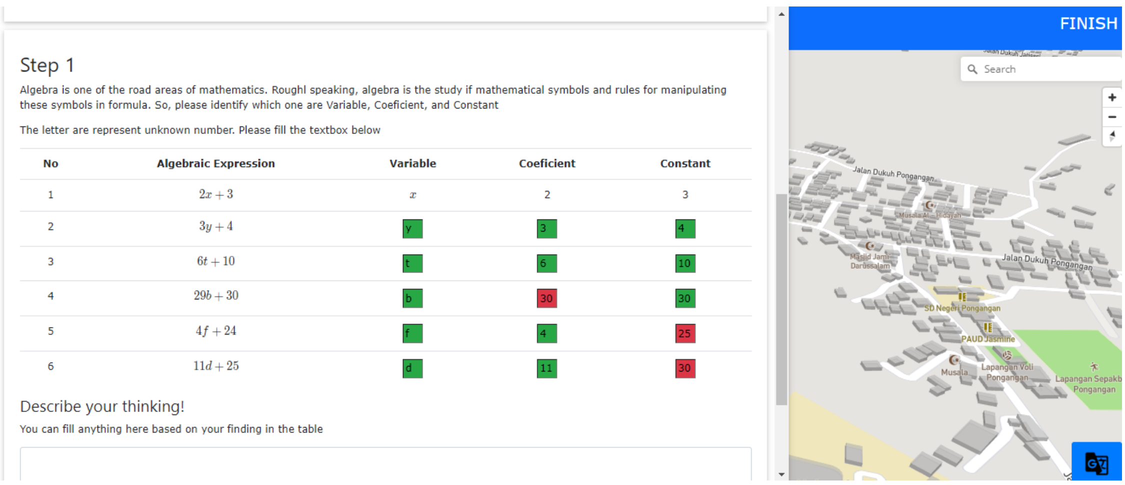

Figure 2. Right and wrong checker

Fun learning activities can increase students motivation to learn. An activity that can raise student motivation is the math trail (Cahyono et al., 2020). Activities involving math trails will be aided by the use of paper and instructional materials. Floor plans and augmented reality (AR) are available in the learning media and can be used to create instructional papers. Figure 3 depicts the media display.

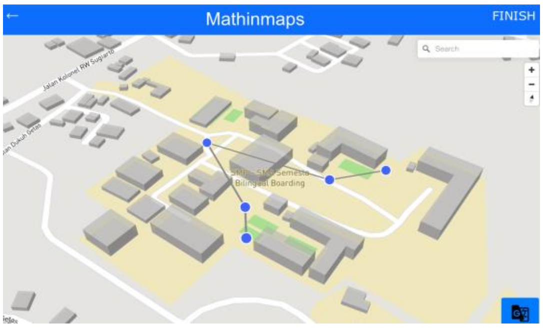

Figure 3. Math trail menu

An experiment with design is then conducted after all the learning resources have been modified to meet the interests of the students. In class 9 in September 2022, the experiment was carried out over the course of 4 meetings. The first three meetings take place in a classroom. Worksheets and mathinmaps.net media are used to implement learning in the classroom.

Figure 4. Learning activities in the classroom

The mathinmaps.net application is used to teach mathematical modeling in a group setting. Students are taught how to cooperate with one another through this learning. Each task on the worksheet is completed by students' in-depth discussions. The teacher was questioned by several group representatives regarding any instructions that were unclear or required clarification. Students are free to form groups anywhere in the room, not just at the table. Some students didn't immediately provide the right response, but thanks to a feature on mathinmaps.net, students can check their right or wrong responses.

The fourth meeting is a task-solving session for items found outside the classroom. Three tasks are completed by the students in a trail. In each post, the teacher offers scaffolding to assist students in coming up with ideas for their assignments. For some groups, reading the instructions already posted on the mathinmaps.net portal is sufficient.

Figure 5. Math trail activity

Several analyses were used to process the data that was gathered during the four meetings. first, to ascertain how learning affects interest in learning. Data was collected using student learning interest questionnaires and learning responses to mathematical modeling based on math trails with AR. With significance values of 0.9479 and 0.2481, both data are normally distributed. A linear model was produced and is depicted in the figure after both data were made into scatter plot diagrams. There was a lot of outlier data found. As a result, these two data will be used to test the linear model.

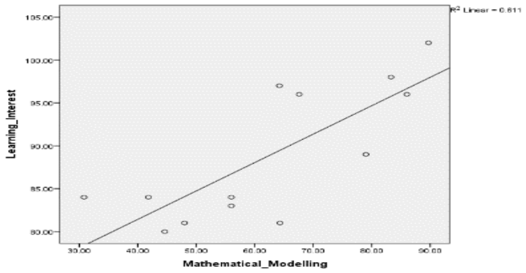

Figure 6. Scatterplot data

The next step is a linear regression test to determine the validity of the linear model, the regression equation, and the degree to which math trail-based mathematical modeling with augmented reality affected students' learning interest. With a sig = 0.00 value, the linear model is accepted. As a result, there is a linear relationship between math learning interest and AR and trail-based mathematical modeling. The relationship between learning mathematical modeling based on AR and students' learning interests will be modeled using the linear model.

The regression equation derived is Y=58.1197+0.5111X. This indicates that every 0.5111 units of X, the value of Y rises. The results visualization demonstrates learning interest at a constant value of 58.1197 with any learning and increases the quality of learning math trail-based mathematical modeling with AR every 0.5111 units.

The value of r = 0.78, indicating a strong correlation between math trail-based mathematical modeling learning and AR (X) and learning interest (Y). While 39.3% of students are influenced by other factors, learning math trail-based mathematical modeling with augmented reality can affect students' interest in learning by as much as 60.7%. Students' in-depth and insightful responses have revealed additional influencing factors, such as teachers who already teach subjects like mathematics and the fact that it is in fact required. Table 1 shows the learning interest of students before and after math trail-based mathematical modeling learning with augmented reality.

Table 1. Table of learning interest in mathematics

No	Dimension	Learning Interest(LI)		N-Gain
		Pre	Post	(g)
1	Attitude	83.4	95.4	0.36
2	Initiative	85.5	92.3	0.22
3	Confidence	70.86	81.14	0.23
4	Motivation	72.36	88.54	0.37
	Average	77.45	89.54	0.31

After that, based on math trail with AR, a retrospective analysis of students' interest in learning mathematical modeling was conducted. In general, moderate category students' interest in learning increased (g=0.31). After learning, students typically retain their interest well (LI = 89.54). The average increase in student interest in learning mathematics was seen across all dimensions.

Moderate growth (g=0.36) has been observed in the Attitude dimension. Some students questioned what activities would be done at the meeting that day before class even started. When students first meet the teacher before class, one of the questions they frequently ask is, "Sir, what do you do with math later?" Before the third meeting, students were anticipated to learn mathematics in this manner. This demonstrates the fruitful impact of the two initial meetings where students eagerly anticipate learning. Additionally, students are working harder to prepare for this lesson's post-test. Students were asking the teacher more frequently than before. However, this could be affected by the pre-testing they did. Each student concentrates when the teacher gives instructions at the beginning of the lesson, but occasionally students must check with the teacher again by asking about the portion of the assignment that requires confirmation (Silitonga & Wu, 2019). With the intention of ensuring student comfort and preventing distraction from other groups, students are given the freedom to complete worksheets. Each student collaborates closely with the group they are in during the learning process. Students with high and moderate mathematical aptitudes assist their peers who struggle to comprehend the tasks at hand.

A low improvement (g=0.22) has been seen in the Initiative dimension. Before learning (LI=85.5), students already take positive actions, and they continue to do so after learning (LI=92.3). Some of the tasks being completed are questioned by the students regarding unclear instructions. One group has a tendency to learn passively, so the teacher must take initiative to monitor the development of each group. Students in the group who participated in the deepening fall into low achievement categories. When students' completed worksheets distributed by the teacher in groups, another issue arises. Without the teacher's permission, students distribute tasks among their group members. This demonstrates the students' initiative in finishing the tasks assigned

(Kusuma et al., 2020).

Low growth is observed for the Confidence dimension (g=0.21). But from the less favorable category (LI=70.86) to the favorable category (LI=81.14), self-confidence rose. Students no longer worry about the answers that will be sent thanks to the answer checker feature. Most students are more likely to ask questions of the teacher when they write answers. This demonstrates that students are not entirely confident in the answers they submit, but the answer checker feature also causes students to submit answers less frequently and with less anxiety. This is less in line with the fact that students are becoming more anxious about their upcoming math grades (g=-0.02). Students claim that since they are only familiar with this type of question structure, the exam questions must be more challenging and novel. Students must quickly adjust to the problem models in the worksheets because they don't often work on the kinds of problems in them (Otoo et al., 2018).

There has been a slight increase in the Motivation dimension (g=0.37). The overall level of student motivation rose. The students' enthusiasm for completing each task on the worksheet served as a marker for this increase. Students who use the mathinmaps.net application perform tasks more practically because the system automatically records and grades their work. Additionally, teachers who instruct students have an impact on their motivation. One of the reasons students study mathematics is because of teachers who have been in the classroom for more than a year. Students also feel more refreshed as a result of the impact that outdoor learning has on their enthusiasm for learning. Responses from students as to why they prefer learning outside of the classroom include the opportunity to go for walks, breathe fresh air, or create vlogs. A variety of activities combined make learning mathematics more engaging. However, rather than relying solely on augmented reality, many students prefer learning outside the classroom (math trail). This indicates that the effectiveness of augmented reality in this lesson was subpar, but math trail-based learning can serve as a learning resource that forces students to review material when they become disinterested in in-class activities (Cahyono, 2018; Cahyono et al., 2020).

In general, learning math with augmented reality has a positive impact on students' interest in the subject, but this learning's potential is still not fully realized. This learning environment can be made better in a number of ways. The worksheet's assignments need to be modified to reflect the frequent material that students encounter. It is possible to add more detail to each step of modeling for each map. Emoticons or more interesting images can be added to the display to make it more engaging.

CONCLUSION

The effect of learning math trail-based mathematical modeling with augmented reality on students' learning interest is 60.7%. Learning and interest in learning have a very strong and favorable relationship (r=0.78). As the math trail-based mathematical modeling learning environment with AR is implemented, each dimension of learning interest grows. A thorough analysis reveals that learning outside of the classroom has a greater impact on motivation than using augmented reality. Therefore, more research is required to maximize AR while learning. Because of this, additional research will be conducted to examine the use of mathinmaps.net media more thoroughly by maximizing the AR function as a replacement for actual objects.

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