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Psychology of Learning in Geometry Course with Augmented Reality Technology

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Abstract: Mathematics, as a main course in schools throughout the world, is essential to be improved. There are some challenges in the field of mathematics education that avoid students to learn more mathematics. Two of them are lack of motivation and anxiety. However, the rapid development of technology nowadays can be used by educators to overcome, or at least to reduce, those obstacles. One of thetechnology that can be used is Augmented Reality (AR). Moreover, AR blends fantasy and reality and is developed to see the impact on pupil's anxiety. This research aims to determine the effectiveness of AR on pupils' anxiety in mathematics course. This research implements a quantitative approach with the type of research quasi-experiment and with the design of the pretest-posttest control group design. The research sample involves 374 fourth grade pupils in junior high school at Bogor residence. The conclusions of this research are pupils who apply augmented reality show higher learning motivation than pupils who do not use augmented reality. In addition, pupils who used augmented reality in teaching materials in geometry class have lower mathematics anxiety than pupils who did not use augmented reality.

Keywords: augmented reality, geometry, learning motivation, mathematics anxiety

INTRODUCTION

Teachers and lecturers throughout the world are significant contributors in field of education because they are people who directly communicate with pupils (Fink, 2013). Educators have a crucial role in developing the essence of education, but in actuality there are several challenges that educators must face to obtain their goals in order that the preferred quality can be achieved (Macfadyen& Dawson, 2010). One of the challenges that need to be faced is anxiety that is sensed by pupils, especially subjects that are relatively unpleasant to learn such as mathematics (Tulis& Fulmer, 2013). This anxiety is the key to achieving learning accomplishment. Anxiety is an internal factor that affects learning outcomes (Hidayat, 2017).

There is another impact of math anxiety, namely it can reduce motivation in learning, especially mathematics. (Mutodi&Ngirande, 2014). Students should increase their learning motivation also then they can achieve their targets in the school(Cauley& McMillan, 2010). In other words, educators need to condition the learning process so thatpupils do not feel excessively anxious while learning and can be further motivated to learn so that there is no sense of being forced to learn teaching material at school. The characteristics is important to grow the motivation for each student to become a lifelong learner(Wlodkowski& Ginsberg, 2017).

Multimedia, especially in and after covid-19 outbreak, can be used maximally to stimulate learning motivation (Yang et. al, 2020). The rapid development of technology, especially after the 4.0 generation technology, has made schools in Indonesia use technology in the learning process (Maryanti, et. al, 2020). Nowadays, schools and universities throughout the world apply technology to support their teaching and learning process (Sharples, et. al, 2010). It's just that the complete technological

facilities have not been able to be maximized by educators to motivate pupils to be able to understand the material well (Ghavifekr&Rosdy, 2015). However, in some areas such as in developing countries, not all teachers and lecturers agree to use technology to support their teaching (Sobaih, et. al, 2016). This is because they are not familiar enough to use those apps. In other words, today's mathematics teachers are still reluctant to use technology media to explain mathematical concepts (Kyriakides et. al, 2016). As a result, teachers and other significant contributor in education should support governments to apply technology in classrooms widely then the objectives of learning can be achieved easily and rapidly(Henard&Roseveare, 2012).

Scientists and researchers have developed hardware and software that can be used by teachers and students to support their activities in the classrooms, especially in mathematics course (Kelly &Lesh, 2012). One of them is an augmented reality application. Specifically, augmented reality is an app that is developed to convert 2D into 3D geometry. (Wang, et. al, 2018). The use of 3D animation becomes interesting for pupils so that pupils are expected to be more motivated in learning mathematics (Hadgood& Ainsworth, 2011). That being said, students will experience less stress in mathematics courses (Yeager & Dweck, 2012).

Based on the explanation that has been described above, researchers are interested in conducting research with the title "psychology of learning in geometry course with augmented reality technology ". The purpose of raising the title into research is because researchers want to find out whether the latest technology in the form of augmented reality can increase pupil motivation and reduce math anxiety, both in pupils with high anxiety and pupils with low anxiety.

The main point why this study is important to conduct is that the rapid development of technology nowadays should be used to support students to understand comprehensively their courses, especially in mathematics classroom. If they are not prepared as quickly as possible and from the beginning of their educational age, it is impossible for pupils to lose their competitiveness in the future, especially in the current era of globalization (Hidayat, et. al, 2019).

Based on the above background, the writer conducted research with the research question, is there a difference in learning motivation between pupils who use augmented reality and pupils who do not use augmented reality? Another research question is whether there is a difference in math anxiety between pupils who use augmented reality and pupils who don't use augmented reality?

METHODS

Sample

There are 374 students from 5 different schools located in Bogor, Indonesia. They do not have an experience in using augmented reality in the classrooms for educational activities.

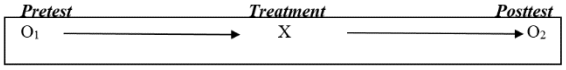
Design

Researchers decided to use quasi-experimental design in this study. The research method is a method of solving research problems that is carried out in a planned and careful manner with the intention of getting facts and conclusions in order to understand, explain, predict and control the situation (Nilson, 2016). Therefore, the researchers also decided to use quantitative approach to analyze the data.

According to Nilson (2016), this form of experimental design is a development of true experimental design, which is difficult to implement. In this design, there are two groups, namely experiment group and control group that are used to be compared each other. Quasi experimental design was used because in reality it was difficult to find a control group used in the research (Brom et. al, 2011).

The use of quasi experimental design involves one group pretest and posttest design. According to Sugiyono (2012), one group pretest and posttest design is a technique to determine the effects before and after treatment.

In a chart, the pretest and posttest designs can be described as follows:



Description:
O_1 = Pretest
X = Treatment
O_2 = Posttest

Picture 1. *onegroupprettestposttestdesign* (Sugiyono, 2012)

Procedure

The order in conducting research should follow steps consecutively in order to the results can be concluded successfully. The research procedure is the activity steps in the research that is taken in conducting the research, the procedure used in this research has three stages, namely:

1. Preparation Stage

a. Make observations
b. Collect literature and conduct literature studies on Mathematics subjects, especially geometry
c. Establish competency standards, basic competencies, subjects, and sub-subjects to be used in research.
d. Develop a learning implementation plan based on competency standards and basic competencies that will be used in research.
e. Prepare teaching materials based on the subject and sub-topic.
f. Create an instrument grid
g. Making research instruments in the form of objective tests
h. Create an answer key
i. Conduct sample trials outside the sample class
j. Analyze question items by testing validity, reliability, difficulty level, and differentiation power to get the correct research instrument.

2. Implementation Stage

a. At this stage, implementation of the researchers went directly to the field. The research stages carried out are as follows:
b. Taking research samples in the form of existing classes
c. Give a pretest
d. Implement learning using augmented reality in the experimental class for 1 month
e. Give a posttest

3. Reporting Stage

a. Analyze and process research data
b. Reporting of research results

Collecting Data

In collecting the data, researchers implement questionnaire and documentation. More specifically, the instruments used to collect data in this research were the Abbreviated Math Anxiety Scale (AMAS) and Mobile Augmented Reality Questionnaire (MARQ). AMAS is used to determine the level of pupilanxiety. MARQ is used to measure the student's attitudes toward using mobile augmented reality instructional materials in class, included 16 five-point Likert-type scale questions and three open-ended questions. Pupils are given a questionnaire to measure math anxiety. The questionnaires given were AMAS and MARQ. After being given questionnaires, pupils were divided into 2 groups. One class for the experimental class and the other for the control class. The experimental class is a class that is given lessons using Augmented Reality, while the control class is a class that is given lessons using conventional methods.

Data Analysis Technique

Data obtained by the researchers are not the final data that can be shown as the conclusion. It needs an interpretation by using analysis of interpretation. The analysis process itself begins with data processing, where coarse data is managed into finer data, so that from the finer data it is obtained something called information. The data obtained were grouped into qualitative data and quantitative data. The main difference between qualitative and quantitative data is the form of the obtained data.

This research uses data analysis techniques with a descriptive quantitative method approach, which in this quantitative data processing processes the pretest and posttest results. The data processing steps are data quality test, classical assumption test, and hypothesis testing.

RESULTS AND DISCUSSION

Learning Motivation

The first research question is that is there a significant difference between pupils who learn using augmented reality and pupils who do not use augmented reality in learning motivation.

Table 1.
Learning Motivation

Groups	Attention Mean/SD	Relevance Mean/SD	Confidence Mean/SD	Satisfaction Mean/SD	N
Augmented Reality					
High-anxiety	34,76/ 4,25	37,62/ 3,82	23,26/ 2,73	28,43/ 3,53	101
Low-anxiety	33,61/ 4,12	36,14/ 4,84	21,12/ 2,53	24,68/ 2,79	83
Non Augmented Reality					
High-anxiety	21,44/ 5,47	27,53/ 3,27	13,32/ 2,36	16,72/ 4,48	87
Low-anxiety	21,67/ 5,56	28,78/ 3,96	16,64/ 2,56	20,22/ 4,52	103

Table 2.
Test of Simple Main Effects – Learning Motivation

	SS	Df	MS	F
Anxiety Levels				
Low	152,31	1	152,31	57,12
High	425,15	1	425,15	162,42
Error		40,31		
Group				
Augmented Reality	48,13	1	48,13	15,42
Non Augmented Reality	24,13	1	24,13	17,23
Error		39,5		

There are four aspects that are counted into consideration as indicators of learning motivation, namely attention, relevance, self-confidence, and satisfaction. ANOVA was used in conducting this analysis using the results of the mathematics anxiety questionnaire as the dependent variable and the results of the motivation questionnaire as the independent variable. Students who use augmented reality in their geometry classrooms pay more attention to teacher's explanation than the ones who do not use augmented reality technology in the classrooms.

Moreover, in the second indicator, the first group, the one who are in the experiment class, show more self-confidence than the second group. More

specifically, pupils with high math anxiety who learn with augmented reality have even higher confidence than pupils with low math anxiety who don't use augmented reality.

The result of satisfaction indicator shows that students in the experiment group are more satisfied in learning mathematics, especially geometry than the students in the control group.

Mathematics Anxiety

The second research question is that is there significant difference in math anxiety between pupils who learn with augmented reality and pupils who don't use augmented reality in learning activities? The researcher used the ANOVA test with the mathematics anxiety pre-test score as a covariate, the anxiety level as the dependent variable and the post-test anxiety score as the independent variable. The result of homogeneity test, it is found that there is a significant interaction between the experimental class and the level of anxiety. The test results show that pupils who learn with augmented reality show lower math anxiety than pupils who don't use augmented reality. In the experimental class, pupils with high learning performance have lower math anxiety than pupils who have low anxiety. However, Conversely, in the control class, pupils with high learning performance experienced higher math anxiety than pupils with low anxiety.

Table 3.
Math Anxiety

Groups	Mean	SD	N
Augmented Reality			
High-anxiety	21,75	4,23	101
Low-anxiety	27,52	4,31	83
Non Augmented reality			
High-anxiety	40,52	5,62	87
Low-anxiety	34,11	5,28	103

Table 4
Test of Simple Main Effects – Mathematics Anxiety

	SS	Df	MS	F
Level				
Low	1.234,11	1	1.234,11	173,13
High	1.387,13	1	1.387,13	142,42
Error		40,31		
Group				
Augmented reality	331,32	1	331,32	27,91
Non augmented reality	297,19	1	297,19	28,13
Error		39,5		

Discussion

Some scholars show the result of their study that the use of advanced technology in the classroom will increase student behaviour (Shroff, et. al, 2011; Blasco-Arcas, et. al, 2013). Specifically, the attitude referred to is concern and relevance. The conclusion obtained by the researchers in the study shows that students who learn by using augmented reality have better results than students who do not use augmented reality in the learning process. The use of augmented reality helps pupils visualize learning objects rather than just learning from books that only display 2-dimensional images. This fact is an important data to develop more study to enhance student understanding in complex formula in geometry course.

Students in the experiment group show higher self-confidence and satisfaction than the ones in another

group.Furthermore, pupils with high anxiety have better self-confidence and satisfaction than pupils with low anxiety when learning with augmented reality. Pupils with high anxiety who did not learn with augmented reality had lower self-confidence and satisfaction. That being said, this result can be used as a basis data to implement augmented reality technology in order to decrease mathematics anxiety.

These study show the same result with the study conducted by other researchers which stated that augmented reality can increase learning motivation and student performance. The difference between the use of augmented reality in learning is also the same as the results of research conducted by Martin-Gutierrez, et. al (2015) which state that combining some interesting aspects, such as 3D animation, text, colour, and audio, in learningcompared to conventional methods.

Another result is that students in the control class have no difference between in their pre-test and post-test results. However, in the experimental class pupils with high anxiety have low math anxiety. Pupils with high and low anxiety have low math anxiety when learning with augmented reality. In conclusion, this shows that augmented reality in smartphone is effective to reduce math anxiety.

The outcomes of the study are also consistent with the results of research stated by Carey, et. al (2016) which states that mathematics anxiety can affect mathematics learning outcomes. Not only does it affect learning outcomes, but math anxiety can also reduce motivation to learn mathematics.

CONCLUSION

This study was conducted to find the fact out of the integration of technology in mathematics classroom. This can be used to overcome student's problems such as learning motivation and math anxiety that are common in the school. The results showed that pupils who used augmented reality in their learning activities showed higher learning motivation and lower math anxiety.

The research results show that the use of educational technology, especially during and after the pandemic, cannot be separated from the field of education. after the pandemic ends, teachers should continue to use technology in teaching and learning activities. Augmented reality is one of technology that can help increase learning motivation and reduce math anxiety. Thus, the use of augmented reality should be regularlyimplemented in schools throughout the world.

REFERENCES

1. Blasco-Arcas, L., Buil, I., Hernández-Ortega, B., & Sese, F. J. (2013). Using clickers in class. The role of interactivity, active collaborative learning and engagement in learning performance. *Computers & Education*, *62*, 102-110.
2. Brom, C., Preuss, M., &Klement, D. (2011). Are educational computer micro-games engaging and effective for knowledge acquisition at high-schools? A quasi-experimental study. *Computers & Education*, *57*(3), 1971-1988.
3. Carey, E., Hill, F., Devine, A., &Szücs, D. (2016). The chicken or the egg? The direction of the relationship between mathematics anxiety and mathematics performance. *Frontiers in psychology*, *6*, 1987
4. Cauley, K. M., & McMillan, J. H. (2010). Formative assessment techniques to support student motivation and achievement. *The*

clearing house: A journal of educational strategies, issues and ideas, *83*(1), 1-6.

5. Fink, L. D. (2013). *Creating significant learning experiences: An integrated approach to designing college courses*. John Wiley & Sons.
6. Ghavifekr, S., &Rosdy, W. A. W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science*, *1*(2), 175-191.
7. Habgood, M. J., & Ainsworth, S. E. (2011). Motivating children to learn effectively: Exploring the value of intrinsic integration in educational games. *The Journal of the Learning Sciences*, *20*(2), 169-206.
8. Henard, F., &Roseveare, D. (2012). Fostering quality teaching in higher education: Policies and practices. *An IMHE Guide for Higher Education Institutions*, 7-11.
9. Hidayat, A. (2017). KonsepDiri Dan Kecemasan Mahasiswa Dalam Pemecahan Masalah Matematika Bisnis Ditinjau Dari Perbedaan Gaya Kognitif Field Dependent Dan Field Independent. *Gammath: JurnalIlmiah Program Studi Pendidikan Matematika*, *2*(1), 55-66.
10. Hidayat, A., Friska, Y., Anggraini, A., Syafi'i, M. T., & Kusumaningsih, A. (2019). Peningkatan Keterampilan Dasar Matematika dan Bahasa Inggris Sebagai Upayadalam Menghadapi Tantangan Era Revolusi Industri 5.0. *Abdimisi*, *1*(1), 55-62.
11. Kelly, A. E., &Lesh, R. A. (Eds.). (2012). *Handbook of research design in mathematics and science education*. Routledge.
12. Kyriakides, A. O., Meletiou-Mavrotheris, M., & Prodromou, T. (2016). Mobile technologies in the service of students' learning of mathematics: the example of game application ALEX in the context of a primary school in Cyprus. *Mathematics Education Research Journal*, *28*(1), 53-78.
13. Macfadyen, L. P., & Dawson, S. (2010). Mining LMS data to develop an "early warning system" for educators: A proof of concept. *Computers & education*, *54*(2), 588-599.
14. Martín-Gutiérrez, J., Fabiani, P., Benesova, W., Meneses, M. D., & Mora, C. E. (2015). Augmented reality to promote collaborative and autonomous learning in higher education. *Computers in human behavior*, *51*, 752-761.
15. Maryanti, N., Rohana, R., &Kristiawan, M. (2020). The Principal's Strategy In Preparing Students Ready To Face the Industrial Revolution 4.0. *International Journal of Educational Review*, *2*(1), 54-69.
16. Mutodi, P., &Ngirande, H. (2014). Exploring mathematics anxiety: Mathematics students' experiences. *Mediterranean Journal of Social Sciences*, *5*(1), 283-283.
17. Nilson, L. B. (2016). *Teachingatitsbest: A research-based resource for college instructors*. John Wiley& Sons.
18. Sharples, M., Taylor, J., & Vavoula, G. (2010). A theory of learning for the mobile age. In *Medienbildung in neuen Kulturräumen* (pp. 87-99). VS Verlag fürSozial wissenschaften.
19. Shroff, R. H., Deneen, C. C., & Ng, E. M. (2011). Analysis of the technology acceptance model in examining students' behavioural intention to use an e-portfolio system. *Australasian Journal of Educational Technology*, *27*(4).
20. Sobaih, A. E. E., Moustafa, M. A., Ghandforoush, P., & Khan, M. (2016). To use or not to use? Social media in higher education in developing countries. *Computers in Human Behavior*, *58*, 296-305.
21. Sugiyono. (2012). *MetodePenelitian Pendidikan:(Pendekatan Kuantitatif, Kualitatif dan R&D)*. Bandung: Alfabeta

22. Tulis, M., & Fulmer, S. M. (2013). Students' motivational and emotional experiences and their relationship to persistence during academic challenge in mathematics and reading. *Learning and Individual Differences*, *27*, 35-46.
23. Wang, P., Wu, P., Wang, J., Chi, H. L., & Wang, X. (2018). A critical review of the use of virtual reality in construction engineering education and training. *International journal of environmental research and public health*, *15*(6), 1204.
24. Wlodkowski, R. J., & Ginsberg, M. B. (2017). *Enhancing adult motivation to learn: A comprehensive guide for teaching all adults*. John Wiley & Sons.
25. Yang, X., Zhang, M., Kong, L., Wang, Q., & Hong, J. C. (2020). The Effects of Scientific Self-efficacy and Cognitive Anxiety on Science Engagement with the "Question-Observation-Doing-Explanation" Model during School Disruption in COVID-19 Pandemic. *Journal of Science Education and Technology*, 1-14.
26. Yeager, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational psychologist*, *47*(4), 302-314.