



Using Augmented Reality Virus (VAR) Application Media to Improve High School Students' Disposition and Creative Thinking Skills

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Abstract: This study aims to reveal the effect of using the Augmented Reality (VAR) Virus Application in arousing the creative dispositions and creative thinking skills of high school students. The research was conducted on 118 class X students at a public high school in Mataram in biology lessons on viruses. The research was conducted using an experimental method pretest and posttest control group design. The experimental class group of students got learning by using the VAR application and the control group using the power point application (ppt). Both classes received pretest and posttest by filling out creative disposition questionnaires and tests of creative thinking skills before and after the intervention. Research data in the form of quantitative data, both creative disposition and creative thinking skills, were tested and analyzed using the N-gain test and difference test. The results of the study revealed that the VAR application aroused students' creative dispositions in the medium category (N-gain 0.41) for the experimental class (VAR application) and in the low category (N-gain 0.23) for the control class (ppt application), both statistically significantly different. The creative thinking skills of VAR class students increased in the moderate improvement category (N-gain 0.32) and in the low category ppt class (N-gain 0.09), both of which also showed significant differences. The conclusion of this study is that the use of the VAR application has the potential to be used as a learning aid for Virus material and is recommended to be suitable for stimulating the growth of creative thinking skills.

Keywords: Creative disposition; Creative thinking skills; Virus Augmented Reality (VAR).

Introduction

The 21st century is characterized by globalization, internationalization and the rapid development of information and communication technology. This situation causes major changes in many aspects of life (Trilling and Fadel, 2009). The changes that have taken place in the 21st century seem to have made the world smaller and smaller. Very advanced developments, especially in the fields of technology, information, and transportation seem to have been able to eliminate and narrow distances, so that the relations between citizens of the world become very easy and fast (Zubaidah, 2016).

These rapid developments and changes bring consequences to every citizen, whether they are ready or

not. The world of education is certainly a field that is responsible for responding to the changes, demands and challenges of life in the 21st century. Education, however, must change its orientation towards the readiness of students who are able to answer and overcome the demands of life in the 21st century. Therefore, education must be directed at a better mindset. Education must focus on how to train and improve critical thinking skills, creativity, collaborative and communication (Mulyasa, 2018). The future of students is greatly influenced by their skills in thinking creatively to produce innovative works that can equip their lives. Creativity is one of the important skills and a pillar of the future life of students, especially in the life of 21st century society (Egan et al, 2017; Sukarso et al,

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2021). Creativity is important to develop so that students have social skills that are ready to face competition in the world of work and economic growth (OECD, 2014).

In education, creativity is better known as creative thinking skills (Supriatna, 2019), namely the ability to think about something in new ways, unusual and sometimes unique as a form of solving various problems (Pusitaningtyas, 2016). The ability to think creatively is described as fluency, flexibility, elaboration and originality (Torrance, 1977). Creative thinking skills can be raised through a learning process that encourages students to think about problems, especially ill structured problems (Sukarso, 2021), actively involves students in finding solutions to their own problems and encourages student-centered learning (Siswono, 2005).

The use of instructional media has been proven to increase student activity and learning outcomes. Now advances in the field of information and communication technology (ICT) open wider and more interesting opportunities for the development of more attractive and interactive learning media. Technology helps and facilitates the needs for the teaching and learning process (Wulandari et al., 2020). This potential should be an opportunity that teachers must take advantage of to develop their learning both in class and outside the classroom. Progress in the ICT field has the potential to be utilized to create learning media that can be developed creatively by teachers (Pusitaningtyas, 2016). The use of ICT-based media in the current pandemic era is a tool that can help the process and success of learning. ICT-based media can play a role in mediating teachers, students and subject matter in conducting indirect interactions between the three. Thus, the learning process can run even without face-to-face meetings.

Unfortunately learning that utilizes ICT-based media is still not the focus of teachers' attention so teachers rarely develop it themselves. Indeed, there are some teachers who are able to operate computers, but in terms of computer compression they are limited. Teachers are constrained by limited knowledge and skills in the ICT field itself. This condition has an impact on teachers who only use media that is already available, without trying to develop and create it themselves. On the other hand, besides being required to be able to utilize existing learning media, teachers can actually develop other media that they make themselves (Nafrin & Hudaidah, 2021).

Android-based software applications are currently the choice for developing learning media, especially for abstract material into a form of real visualization called Augmented Reality (AR). Many research results using Augmented Reality (AR) applications in learning indicate increasing students' perceptions in the abstract to become real (Meslilesi et al, 2017), stimulating intrinsic motivation and student learning outcomes (Zulfiani et al., 2017), stimulating students' mindsets to

think critically in solving problems (Balandin, 2010), to experience 3D displays that create interactive and fun learning and exploring sensations (Puspitasari et al, 2020; Aprillinda et al, 2020).

Android-based Augmented Reality Virus (VAR) is a learning medium created to illustrate the concept of viruses that are considered abstract and can be displayed in concrete form in 2 dimensions (2D) or 3 dimensions (3D) using ICT. This application is made on Virus material for high school students according to the 2013 curriculum where the presentation is designed in 2 dimensions (2D) or 3 dimensions (3D) so that it can stimulate or encourage students to think creatively. Thus, the use of VAR is expected to be an alternative for teaching Virus material and encouraging students to think creatively.

Research related to AR on Virus material in developing students' creativity and creative dispositions, until now is still very rare even if no one has researched it. Viruses as particles that contain elements of life or as living organisms in host cells are often very abstract and cause difficulties for students in learning them. On the other hand, viruses are very close to students' lives, therefore mastery of material about viruses and aspects of creative thinking about viruses is interesting and needs to be studied.

Method

This research was conducted using the pretest and posttest control group design experimental method. The research was conducted on 118 class X MIPA students at a public high school in Mataram City in the 2021/2022 academic year, divided into 64 students as the experimental group and 54 students as the control group. The research sample was determined using a purposive sampling technique, namely by selecting students based on certain considerations or objectives which in this study were based on students having an android device that supports the VAR application for the experimental class and students who do not have an android device used as the control class. The VAR application was self-developed by the researcher, previously validated by IT experts and content, both of which stated that the VAR application was feasible to use. The VAR application is installed on the android device (smart phone) of the experimental class students. Experimental class students conducted learning in the classroom using the help of the Augmented Reality Virus Application (VAR) and the learning control class was carried out using the help of the Virus power point application (ppt) as a tool that is commonly used in Biology classes. Experimental class or control class students get a pretest before learning takes place and get a posttest after learning ends. Data collection techniques using questionnaires and tests. The questionnaire

instrument in the form of a creative disposition questionnaire developed by Sukarso et al (2019) includes inquisitive, persistent, imaginative, collaborative and disciplined dimensions referring to Bill Lucas, Guy Claxton and Ellen Spencer (2013). Questionnaires were given to students with the aim of seeing an increase in the growth of students' character or creative disposition due to the use of the VAR application. The creative thinking skills test instrument in the form of 6 questions in the form of an essay was arranged according to Torrance's Creative Thinking Test (TTCT) from Torrance (1977) which includes fluency, flexibility, elaboration and originality. The creative thinking skills test instrument was made and compiled by the researchers themselves on Virus material for high school.

The research data is in the form of questionnaire results which are quantified into a score range of 0-5 and the quantitative data on the results of the creative thinking skills test are in the form of scores on a scale of 0-100, processed and analyzed by means of different tests using t and N-gain tests. The use of the t test is intended to see the difference in the results of the

treatment given to the research class against the control. N-gain is intended to find out which category of increase occurs in creative dispositions and creative thinking skills. The N-gain calculation refers to Hake (1998) and is categorized into 3 categories: high if $g > 70$, medium if $30 \leq g \leq 70$, and low if $g < 30$ (Meltzer, 2002).

Result and Discussion

Creative Disposition

Creative dispositions are creative individual characters that appear in their daily life, especially when facing a problem or phenomenon. The use of the VAR application in studying Virus material in high school in this study generally indicated an increase in the emergence of students' creative dispositions with an average N-gain of 0.41 or in the moderate improvement category. A summary of the results of data processing for the experimental class (VAR) and the control class (power point/ppt) is presented in Table 1.

Table 1. Summary of results of creative disposition data processing in VAR class and PPT class

Components	Experiment Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Number of students	64	64	54	54
Average Score	2.67	3.64	2.49	3.11
Standard Deviation	0.423	0.47	0.355	0.373
Minimum Score	2.0	3.0	1.6	2.5
Maximum Score	3.6	4.7	3.4	4.4
<i>N-gain</i>		0.41		0.23
Normality Test	0,153 (Normal)	0,200 (Normal)	0.101 (Normal)	0.128 (Normal)
Homogeneity Test	0.393 (Homogeneous)	0.642 (Homogeneous)	0.393 (Homogeneous)	0.642 (Homogeneous)
The mean difference (t' test) creative disposition scores of the experimental class and the control class with a significance of 0.05			Sig.(2-tailed) = 0.000 $\alpha < 0.05$. H_0 is rejected	

Changes (increases) in creative disposition on each dimension varied in the form of scores but were the same by category. This research resulted in different creative disposition change patterns between the VAR class and the PPT class. As many as 9% of the number of students in the VAR class experienced an increase in the high category, 75% of students experienced an increase in the medium category and 16% increase in the low category. This result is different from the PPT class which only experienced an increase with an average N-gain of 0.23 and was included in the low category of increase. Only 2% of students from the PPT class experienced an increase in the high category, 43% in the medium category and the majority of the 54% increase in the low category. This indicates that the use of the VAR application is better than learning assisted by PPT.

The findings above are also supported by the results of a questionnaire on student responses to the use of the VAR application which resulted in as many as 82%

of students feeling able to stimulate their curiosity, triggering the emergence of a tenacious character (persistent), triggering the emergence of imaginative thoughts and developing the level of mastery of viral concepts using the application. VAR. This finding is in line with the research results of Theodoropoulos & Lepouras (2021) that the use of Augmented Reality (AR) allows students to take an active part in lessons or experiment with real-time visualization and observe what is learned at their own pace. This is reasonable because AR itself has many advantages as stated by Mauludin et al (2017) and Meslilesi et al (2017) that the appearance of AR is attractive, displays 3D objects and animations as if it brings users to a real environment and is useful in bringing information that is not directly acceptable to humans.

The mean scores of the pretest and posttest results for changes in creative disposition in the VAR class and ppt class for each domain are summarized in Figure 1

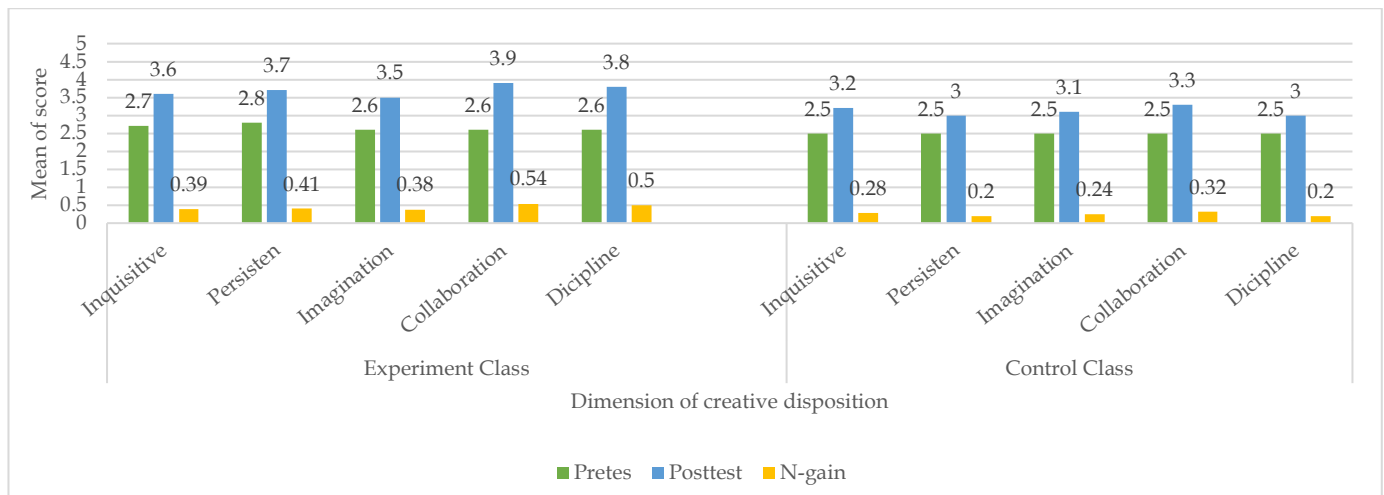


Figure 1. Increasing the emergence of creative dispositions through the use of VAR and the use of PPT.

From Figure 1 it can be seen that the average creative disposition score on the collaboration and disciplined dimensions shows a higher trend of increase (often appearing) compared to the other dimensions with an N-gain of 0.5 in the medium category. This phenomenon shows a more frequent appearance and becomes a habit in terms of joint activities, characters are willing to share knowledge or experiences with others and are open in giving and receiving input from others as a form of collaboration dimension. VAR also encourages the emergence of a disposition in the disciplined dimension shown by the habits of students trying to develop or master certain techniques to create new works, use correct scientific concepts, usually reflect to find out strengths and weaknesses, change something from routine to something unusual.

The phenomenon as a finding in this study is in line with the results of research by Theodoropoulos & Lepouras (2021) who found evidence that AR can motivate collaboration (collaborative), social and communication skills and creativity. Collaboration concerns activities in building positive relationships, working effectively in teams, handling challenging

situations constructively, and developing leadership skills (Batham, 2014). Even though it is in the low improvement category, VAR also has a tendency to increase the frequency in arousing persistent, inquisitive and imaginative thoughts of students. When compared to the control class, the use of VAR tends to increase creative dispositions for all dimensions examined in this study. Runco & Acar (2012) states that all indicators, whether inquisitive, persistent, imaginative, collaborative, and disciplined, can be improved with treatments that train students in creative habits, such as using challenging learning models. In this study the use of VAR seems to be more challenging than the use of PPT in studying Virus material in high school so the results tend to be better.

Creative Thinking Skills (CTS)

Students' creative thinking in research has been measured by using a creative thinking skills test which includes aspects of thinking fluency, flexibility, elaboration and originality. The results of measurements and statistical tests are summarized and presented in Table 2.

Table 2. Recapitulation of pretest, posttest, and statistical test results for students' creative thinking skills

Components	Experiment Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Number of students	64	64	54	54
Average Score	26	49	17	24
Standard Deviation	8.10	16.26	7.81	12.42
Minimum Score	10	17	6	8
Maximum Score	44	82	51	71
<i>N-gain</i>		0.32		0.09
Normality Test	0,112 (Normal)	0,200 (Normal)	0.104 (Normal)	0.165 (Normal)
Homogeneity Test	0.269 (Homogeneous)	0.642 (Homogeneous)	0.269 (Homogeneous)	0.508 (Homogeneous)
The mean difference (t' test) creative disposition scores of the experimental class and the control class with a significance of 0.05			<i>Sig.(2-tailed)</i> = 0,000 $\alpha < 0,05$. H_0 is rejected	

Based on Table 2, it appears that creative thinking skills (CBC) increased from the initial state in both the experimental class and the control class. The level of increase that occurs at $N\text{-gain} = 0.32$ is moderate for the experimental class and $N\text{-gain} = 0.09$ is low for the control class (Melzer, 2002). These findings can be inferred that the use of the VAR application has a better impact on improving students' creative thinking skills in fluency, flexibility, elaboration and originality thinking, compared to the use of power point (ppt) in the control class. The score for an increase of $N\text{-gain} 0.32$ does not seem so high even though it is in the medium category, but at least it is better than the control class in the low category. The students' creative thinking skills in the experimental class showed clustered patterns in two categories, namely the group of students in the moderate improvement category (48%) and the low group (52%) in the number of students. On the other hand, students who study using ppt (control class), all students experience an increase in grouping in just one low category.

In this study, an increase in CBC showed a concordance with an increase in creative disposition, where an increase in creative disposition in the medium category for the experimental class also showed an increase in CBC in the same category. Similarly, the same thing happened for the control class. The results of

the student response questionnaire regarding the use of the VAR application in stimulating the emergence of students' creative thoughts, 69% of students agreed and strongly agreed. In another statement it was also revealed that the VAR application fostered motivation in 88% of students in learning Virus material. Based on this phenomenon, it can be inferred that the VAR application is able to increase the meaningfulness of student learning, especially in generating their creative thinking skills. The VAR application triggers students to come up with ideas, think varied and original.

The use of the VAR application is thought to create a conducive student learning environment. Ching Leen et al., 2014 emphasized that a conducive environment can have an impact and further encourage students to develop their creative thoughts. The VAR application that is presented is believed to have modeled the abstract virus concept to be more concrete and generate better student self-confidence. The research findings of Mardiyah et al (2020) indicate that the Augmented Reality (AR) technology they have developed for learning can meet the needs of improving students' skills in understanding abstract and complex things. In other findings it was revealed that creativity can be stimulated through modeling (Martin & Wilson, 2017) and encouraging confidence in differences can trigger individual creativity (Reisman, 2014).

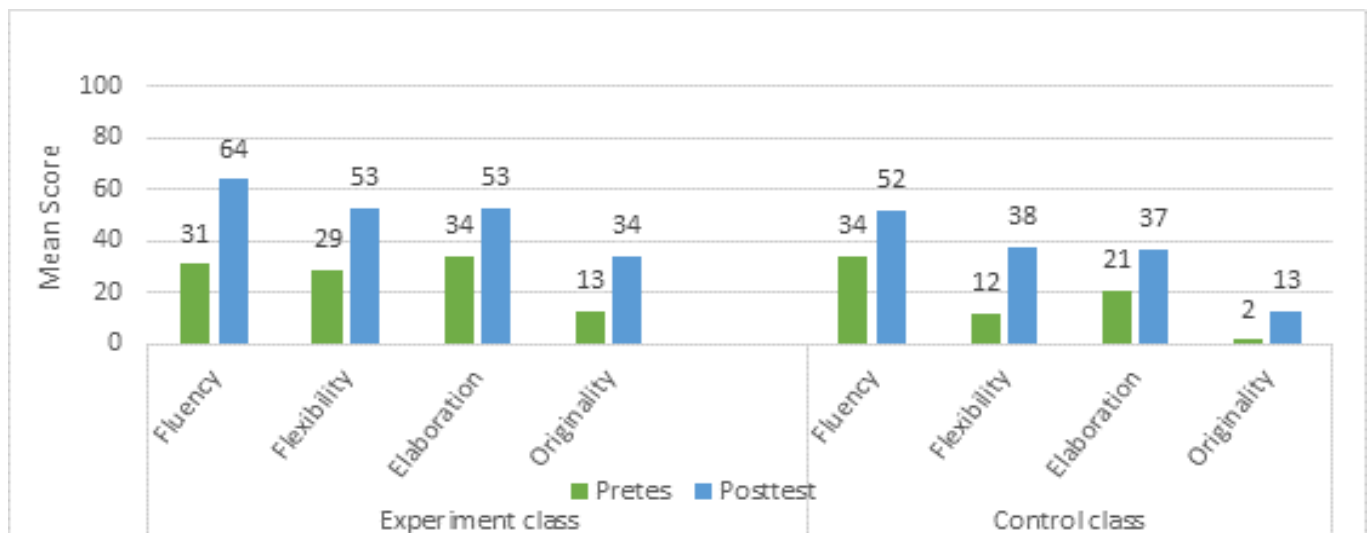


Figure 2. The average score of each indicator of the creative thinking skills of the experimental and control class students

Comparison of the results of creative thinking per indicator shows that the fluency thinking aspect has a higher score than the other indicators (Figure 2) and the $N\text{-gain}$ that occurs in each indicator can be seen in Figure 3. High fluency thinking skills illustrate that students are able to produce ideas or new or unique ideas. The results of research on fluency thinking generally show good fluency thinking skills, but it will decrease for thinking flexibility, elaboration and originality. This phenomenon is also shown in this study (Figure 2) and

it can be inferred that thinking with many varieties, detailed thinking and original thinking are still difficult for students to do even though they have been stimulated by using VAR. On the other hand, according to Kenett et al (2018), flexibility plays an important role in the ability of high creative individuals to generate new ideas. Thinking flexibility causes a variety of ideas that use various conceptual categories (Runco & Acar, 2012). Nonetheless, many scientists argue that the lack of

ideas should not actually be considered a limiting factor for creativity (Scheffer, Baas & Bjordam, 2017).

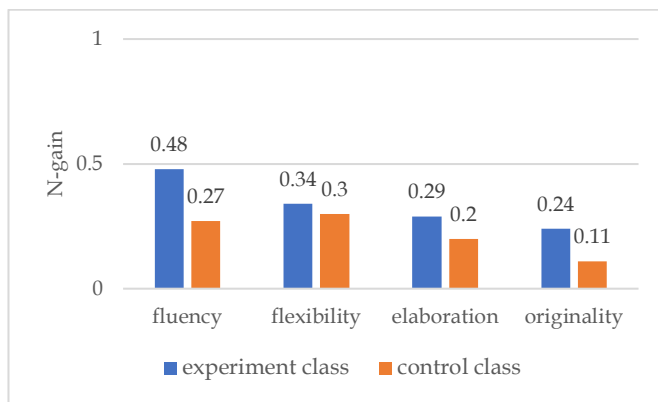


Figure 3. The average of N-gain per indicator in the experimental class and control class

Based on Figure 3 above, the N-gain of the VAR class is higher for all domains of creative thinking skills. The domain that experienced the highest change (N-gain) was shown in two domains, namely flexible thinking and fluency, which included an increase in the moderate category and for the domain of original thinking, which was included in the low category. This applies to both research class groups. The increase in the medium category in the PPT class only occurred for the fluency and flexibility indicators, the others were in the low category.

The use of the VAR application makes students literate in technology and appears to be more enthusiastic about learning. The results of the student response questionnaire indicated that 88% of students strongly agreed and agreed that the VAR application generated motivation in learning Virus material. Hanke (2011) suggests that individuals who understand creative products as something new and useful can stimulate different ways of thinking in the problem-solving process, and can even create not just one solution but produce several other solutions. The VAR application seems to have the potential to develop other concepts that are different from students' previous thoughts because students do something. Students operating the VAR application means conditioning themselves to work on and think about the theme of viruses. This is in line with Torrance (1977) that students' creative thinking skills can increase if they do learn in a way that students are conditioned to work on a project.

The original thinking indicator in the results of this study is still low. Original thinking is a creative thinking skill that is difficult for students to develop as also found in other studies (Alghafri & Ismail; 2014). The role of the VAR application in triggering students to think original is not yet known. Original thinking skills describe the level of students' ability to produce thoughts or actions that are considered unique, namely thoughts or actions

that few people think of the ideas they put forward. The fewer students who think about the ideas generated, the more original the idea will be (Hu & Adey, 2002). It is reasonable to suspect that in this study, students still expressed creative thoughts based on experience, imagined their ideas from their long-term memory, did not use imaginative thinking thereby limiting divergent thinking. On the other hand, divergent thinking contributes to original thinking (Runco & Acar, 2012).

Conclusion

Based on the results of the study it can be concluded that the use of the VAR application tends to be more able to foster creative dispositions and creative thinking skills of students in Virus material. All dimensions of creative disposition significantly increase due to the use of VAR applications and tend to be more prominent in the dimensions of collaboration and discipline. Unfortunately, changes in creative disposition have not been followed by an increase in creative thinking skills that are good and evenly distributed in every indicator of creative thinking. The high increase in creative thinking indicators is still limited to thinking fluency and flexibility. Students in this study, it seems still too difficult to be skilled in thinking elaboration and originality.

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