Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram
https://e-journal.undikma.ac.id/index.php/prismasains/index
e-mail: prismasains.pkpsm@gmail.com

July 2022. Vol. 10, No. 3
p-ISSN: 2338-4530
e-ISSN: 2540-7899
_pp. 409-416_

Effects of Virtual Reality (VR) Video as Asynchronous e-Learning Supplement on Student Learning Outcomes

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Received: April 2022; Revised: May 2022; Published: July 2022

Abstract

The purpose of this study is to explore the impact of virtual reality (VR) videos as asynchronous e-learning supplements on improving student learning outcomes. This study is an experimental study, using two sample groups (experimental and control). The experimental group was taught by presenting virtual reality (VR) videos connected to e-learning in the LMS, and the control group by traditional (face-to-face) or expository learning (without VR). Research participants in each sample group were 24 early semester students who programmed a basic natural science course at the Universitas Pendidikan Mandalika (UNDIKMA). The groups were given the initial task as a pretest, learning treatment, and the final task as a posttest. Learning assignments and descriptions of learning materials are related to the theme of 'climate change.' Test instruments (essays) were employed to measure students' cognitive learning outcomes. The test instrument used fulfills the validity aspect as a psychometric property of the instrument. Data were analyzed descriptively (n-gain parameter), and statistically (analysis of mean differences using independent sample t-test) at a significance level of 0.05. The results of the descriptive and statistical tests showed that there was a significant impact from the application of virtual reality (VR) videos as asynchronous e-learning supplements to the improvement of student learning outcomes. Our findings confirm that virtual reality (VR) videos as asynchronous e-learning supplements are better at improving student learning outcomes when compared to traditional face-to-face (expository) learning. More detailed results are presented in this article.

Keywords: virtual reality (VR) video, asynchronous e-learning, learning outcome

How to Cite: Ismail, I. (2022). Effects of Virtual Reality (VR) Video as Asynchronous e-Learning Supplement on Student Learning Outcomes. _Prisma Sains : Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram_, _10_(3), 409-416. doi:https://doi.org/10.33394/j-ps.v10i3.5214

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INTRODUCTION

The acquisition of knowledge, positive values and skills is the direction to be achieved in the general education process (Kamińska et al., 2019). In general and in a more basic context, the main purpose of education is to prepare students for life, and in the end in a continuous process they can work with the knowledge acquired and in line with honed skills that can be utilized by the community (Wittich et al., 2017). The task of educators on the one hand is to improve the competence of mastery of knowledge and skills of students during the educational path. This task is increasingly complex along with learning needs, developments in science and technology, absorption of the job market and industry, which force changes to the learning and education system (Kamińska et al., 2019). This is not only at the primary or secondary education level, but at all levels of education including higher education.

Changes in the perspective of education actors are needed, especially teachers who play a central role in teaching in the classroom. Teachers need to make adjustments to the learning system in the classroom, this is in line with changes in the learning paradigm that lead to student-centered learning. The next challenge almost experienced by classroom teachers from the past is the weakness of students in problem solving (Yager, 2000). The results of observations based on our focus on science learning show that students' difficulties in solving problems, technical complexity, especially in the context of the material being taught, learning it requires an abstract mindset, and the concepts contained in it are not entirely real. In addition, learning more in-depth concepts requires practical training, this of course requires special research equipment that is carried out in the laboratory and under supervision (Kamińska et al., 2019). Another problem is when there are some students who do not participate in the learning process or experiment in the laboratory, it is difficult for them to catch up with the material that has been trained to other students, rescheduling may create new technical obstacles for the teacher.

The massive use of digital technology today can be a solution to problems faced by students and teachers in classroom learning. For example, the use of online courses (Chang et al., 2022), blended learning (Amenduni & Ligorio, 2022), and many different computer-based digital technology platforms, which allow students to repeat the same topic several times and can certainly increase the quality of their understanding of the topic. Several studies found valuable results and experiences that support online learning platforms can be applied, for example, Chang et al. (2022) found the impact of implementing online strategies on student learning performance and supporting the development of their critical thinking. Compared to traditional courses, blended learning was found to be more effective in improving the quality of learning and supporting student learning performance (Bernard et al., 2014; Vo et al., 2017). The rapid development of technology has attracted researchers to relate it to aspects of attitude. Several studies report that students' attitudes towards learning increase with the use of information and communication technology (Edmunds et al., 2012; Guillén-Gámez et al., 2020; Hoesni et al., 2020; Hõrak, 2019; Lazar, 2018).

The trend of studies related to online learning in the last four years (January 2019 to May 2022) is increasing, this is in line with its increasingly massive use as a substitute for traditional learning during the Covid-19 pandemic. Our search results on the SCOPUS page by searching the keywords 'online learning' found results as shown in Figure 1.

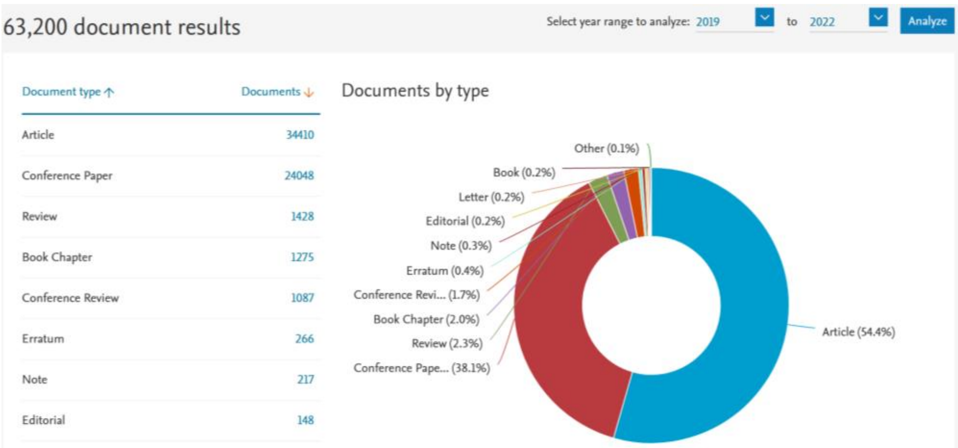


Figure 1. Studies related to 'online learning' in the last four years recorded in the SCOPUS document

The results in Figure 1 show the large number of studies related to online learning, even this trend is likely to continue to increase. The type of article document dominates as much as 34.410 (54.4%), the field of study is more focused on social science, including education and learning. However, in the context of science learning, it seems that online learning is not enough, because it only deals with the 'way'. When the content of science learning leads to natural events or phenomena, empirical evidence is needed, and this almost does not allow learning to be carried out only at the theoretical level. For example, when learning is related to 'climate change' material content, a virtual simulation mode is needed to deepen students' understanding of the material. In connection with previous studies, virtual simulation is also known as virtual reality (VR) (Kamińska et al., 2017).

Studies related to VR to date show that the level of adoption of VR technology in universities has not been done well (Marks & Thomas, 2022), although personally the VR technology is an interesting part of the study when it is conducted in learning (Kamińska et al., 2019). Competencies generated by students with the application of VR in learning include increasing innovative thinking skills, increasing problem solving abilities in students, practicing critical thinking skills and empathy (Hernandez-de-Menendez et al., 2020; Kamińska et al., 2017). The presentation of VR in learning can be a supplement in asynchronous e-learning and is believed to have an impact on better learning outcomes.

The purpose of this study is to explore the impact of the application of virtual reality (VR) video as an asynchronous e-learning supplement to improving student learning outcomes. The findings in this study can later contribute to scientific development, especially empirical evidence from the application of VR video as an e-learning supplement.

METHOD

This study is an experimental study, using two sample groups (experimental and control). The experimental group was taught by presenting virtual reality (VR) videos connected to e-learning in the LMS, and the control group by traditional (face-to-face) or expository learning (without VR). Research participants in each sample group were 24 early semester students who programmed a basic natural science course at the Universitas Pendidikan Mandalika (UNDIKMA). The groups were given the initial task as a pretest, learning treatment, and the final task as a posttest. Learning assignments and descriptions of learning materials are related to the theme of 'climate change' which is taught in two meetings (6 x 50 minutes) for each group.

Learning outcomes are the dependent variable measured in this study, and focused on cognitive learning outcomes. A test instrument (essay) of 10 test items was employed to measure student cognitive learning outcomes. The distribution of questions measuring all aspects of cognitive learning outcomes refers to Bloom's taxonomy (Bloom, 1956). Before being applied as a pretest-posttest, the test instrument was tested for validity to fulfill the psychometric properties of the instrument (Souza et al., 2017). In the context of validity, in this study the content validity parameter is used which explains the measurability of the content domain of the instrument (Sireci & Faulkner-Bond, 2014), it employs expert validators. The result is that the 10 instrument items tested have been declared valid and can be used as data collection instruments in this study.

The scoring criteria for cognitive learning outcomes are presented in Table 1. The minimum score is 0 and the maximum score is 100, this is used for scoring on the performance of individual cognitive learning outcomes and on the overall average. Score intervals and criteria in each of the five categories.

Table 1. Score interval of learning outcomes

Score interval	Criteria
81 - 100	Very good
61 - 80	Good
41 - 60	Sufficient
21 - 40	Less
0 - 20	Not good

Data on improving learning outcomes are analyzed and categorized according to the Hake formulation (normality gain/n-gain), the criteria are: high (n-gain > 0.7), moderate (n-gain 0.3 - 0.7), and low (n-gain < 0.3) (Hake, 1999). Furthermore, the posttest results were compared from the two sample groups and analyzed descriptively and statistically. As a benchmark for statistical testing, the tested data variables meet the normality aspect. This is a reference in the use of different tests (parametric or non-parametric statistics). The average difference was statistically based on a significance level of 0.05. To simplify the test, the SPSS tool is used. The SPSS results snippet is the main finding and discussion in this study.

RESULTS AND DISCUSSION

This study has implemented virtual reality (VR) video technology in teaching the concept of climate change to the experimental group. The mechanism is that students are taught the concept through an e-learning platform in the LMS, and the teacher presents VR videos as a synchronous and asynchronous learning material supplement. The VR video material content is taken from the 'UN Environment Program' source which has been uploaded on youtube which contains 'climate change' content. On the one hand, in the experimental group the teaching is done face-to-face with the presentation of the material directly, this method is better known as expository teaching. The results of the study in each group given the initial task as a pretest, learning treatment, and the final task as a posttest are summarized in Figure 2 (descriptive analysis).

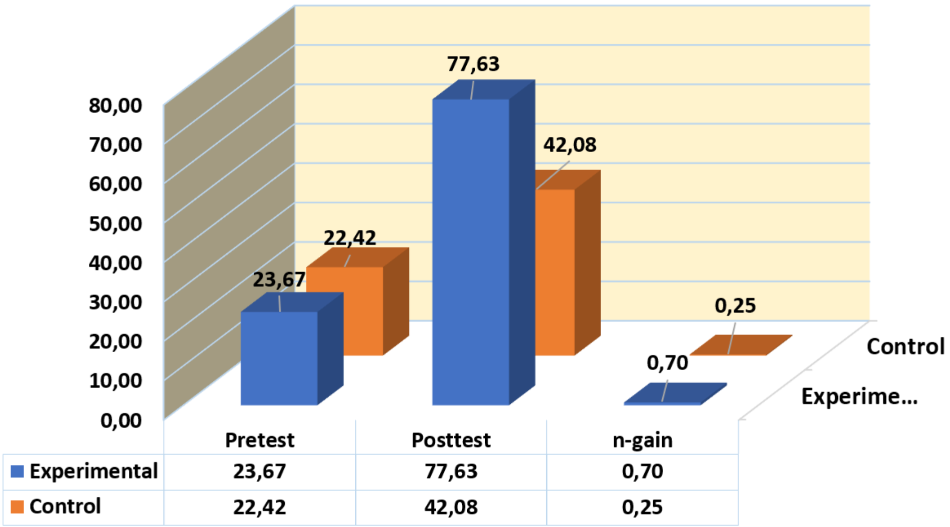


Figure 2. The results of the average pretest, posttest, and n-gain for each sample group

Adopting the scores and learning outcomes criteria in Table 1, the study results show that student learning outcomes in the experimental group are superior to those in the control group. The average posttest score of the experimental group was 77.63 (good), while the control group was 42.08 (sufficient). Their n-gain scores were also different, the experimental group was 0.70 with moderate criteria (almost close to high), and the control group was 0.25 (low) (see results in Figure 2). The difference in n-gain of each individual in the experimental and control groups is presented in Figure 3.

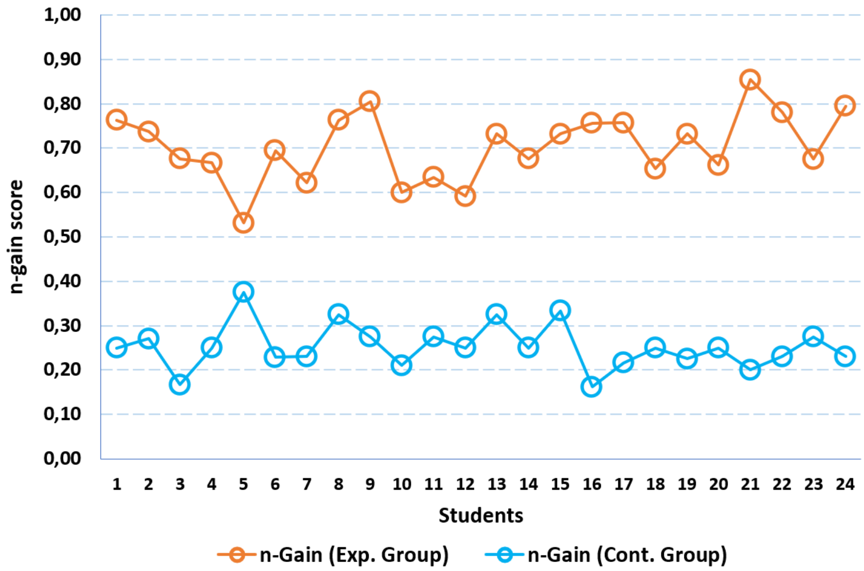


Figure 3. Differences in n-gain of each individual in the experimental and control groups

Students in the experimental group, their average n-gain has moderate criteria. Individually, the highest n-gain score in the experimental group was 0.85 (S-21) and the lowest was 0.53 (S-5). The average n-gain in the control group was low, and individually the highest n-gain score in the control group was 0.38 (S-5) and the lowest was 0.16 (S-16). The results of the descriptive analysis on the performance of student learning outcomes shown in Figures 2 and 3 clearly indicate that virtual reality (VR) videos as asynchronous e-learning supplements are superior in improving student learning outcomes, when compared to traditional teaching (expository).

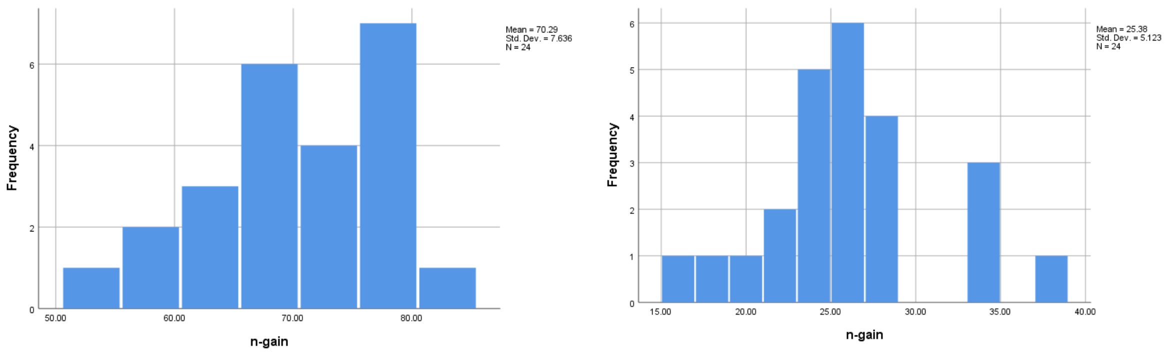
With VR video technology, it allows students to repeat in learning the material independently (asynchronously) so that it has an impact on their deeper understanding. This is of course different in the context of expository teaching. These results convinced the researcher, that one of the most innovative technologies currently in the asynchronous e-learning teaching mode is VR (Achuthan et al., 2020). Furthermore, the differences in the n-gain scores of each group were analyzed. This is to emphasize the impact of applying virtual reality (VR) as a synchronous e-learning supplement to improving student learning outcomes. The initial analysis was to test the normality of the data ($p > 0.05$), this used the Shapiro-Wilk technique and the results (SPSS output) are summarized in Table 2. The results of the independent sample t-test ($p < 0.05$) are summarized in Table 3. Frequency distribution of each groups are presented in the histogram in Figure 4.

Table 2. The normality test output using the Shapiro-Wilk technique, $p > 0.05$

Group	Shapiro-Wilk			Normality
	Statistic	df	Sig.	
Experimental	0.980	24	0.897	Normal distribution
Control	0.943	24	0.193	Normal distribution

Table 3. Output results from independent sample t-test, $p < 0.05$

		t	df	Sig. (2-tailed)
n-Gain parameter of LO	Eq. var. assumed	23.931	46	0.000
	Eq. var. not assumed	23.931	40.218	0.000



(a) (b)

Figure 4. The frequency distribution of each group is presented in a histogram: (a) the experimental group, (b) the control group

The results in Table 3 show that the significance value (2-tailed) (0.000) is greater than 0.05, meaning that there is a difference in the mean n-gain of the two treatment groups (experimental and control) tested. In a more specific context, this difference is the effect of different treatments in each test group. Confirmed from the results of descriptive and statistical tests, it is very clear that there is a significant impact from the application of virtual reality (VR) videos as asynchronous e-learning supplements on improving student learning outcomes. This result is in line with the research findings by Safadel & White (2020) that VR containing instructional content has an impact on many good learning outcomes in science. Meta-analysis of virtual reality (VR) shows that this technology has a positive impact on many educational outcomes (Yu, 2021).

A similar study model was conducted by Barnidge et al. (2022), they studied the effect of VR technology (360° video version, accompanied by text and images) as an effective learning tool on climate change materials. As a result, they found an indirect effect mainly on cognitive elaboration that depends on the respondent's knowledge of climate change (Barnidge et al., 2022). Meta-analysis studies related to the existence of VR and its applications are more inclined to areas connected to nature, and it is found that learning about natural sciences is most interesting when simulated with VR technology, especially those related to environmental issues (Smutny, 2022). This is empirically proven in the current study, that the application of virtual reality (VR) videos as asynchronous e-learning supplements has an impact on improving student learning outcomes.

Finally, based on the results of the current empirical study, we recommend the application of virtual reality (VR) video as a supplement to asynchronous e-learning in regular classroom learning, especially to teach materials related to climate change. The preparation of material content in VR is not an obstacle, considering that there are many platforms related to VR in the form of videos and are found on many providers on the internet and can be accessed freely, so this can also be an opportunity for optimal utilization in learning.

CONCLUSION

The results of the descriptive and statistical tests showed that there was a significant impact from the application of virtual reality (VR) videos as asynchronous e-learning supplements to the improvement of student learning outcomes. Our findings confirm that virtual reality (VR) videos as asynchronous e-learning supplements are better at improving student learning outcomes when compared to traditional face-to-face (expository) learning.

RECOMMENDATION

Finally, we recommend the application of virtual reality (VR) video as a supplement to asynchronous e-learning in regular classroom learning, especially to teach materials related to climate change.

ACKNOWLEDGMENT

The author would like to thank the suggestions from many parties, the involvement of the research respondents, the university that gave the permission to carry out the research, and the people involved in the administration of the research.

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