IJORER : International Journal of Recent Educational Research
Homepage : https://journal.ia-education.com/index.php/ijorer
Email : ijorer@ia-education.com

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 4, No. 1, January 2023
Page 59-67

Analysis of Students' Critical Thinking Skills on Virtual Reality Learning Media

Faradila Aulia' Alifteria[1*], Tjipto Prastowo[2], Nadi Suprapto[3]
[1,2,3] State University of Surabaya, Surabaya, Indonesia

DOI: https://doi.org/10.46245/ijorer.v4i1.275

Sections Info

Article history:
Submitted: November 29, 2022
Final Revised: January 7, 2023
Accepted: January 17, 2023
Published: January 31, 2023

Keywords:
Critical thinking skills
Learning media
Problem-based learning
STEAM
Virtual Reality

ABSTRACT

This study aims to describe students' critical thinking skills and the corresponding prior knowledge of Virtual Reality (VR) media used for learning purposes in a classroom setting. A total of 65 high school students from Grade XI Science 1 and Science 2 were involved as respondents in this preliminary research using qualitative-descriptive analysis. The instrument used included questionnaires (distributed over the respondents) containing 12 questions on VR relevant to the indicators of critical thinking skills. The results showed students' skills in critical thinking at the intermediate level. The indicator of analytical ability has the highest percentage in the medium category. The number of students with critical thinking skills in the high category is 14, and in the medium category, as many as 51 students. Students' prior knowledge of VR media (familiar with the technology) was reported to 46.00% of all the respondents, and the remaining 54.00% did not know what it was. However, all the respondents were interested and happy with VR media as a learning tool. Improvement of critical thinking skills could be achieved through contextual learning and VR learning media. The implication of the present study for future use of VR education media in schools is possible as VR media is considered to be technology-assisted learning, applicable to science and physics teachers when delivering learning materials in class.

INTRODUCTION

The development of science and technology greatly affects the practice of teaching and learning in the field of education (Amri, 2015; Pangestuti, 2020). The portrait of education is not only seen as teaching and learning activities but also as a collaborative process between educators and students in creating a learning atmosphere that supports educational goals following the demands of the curriculum (Mardiki & Virginayoga, 2019; Prayudha et al., 2017). The tendency of learning physics so far is that students only study physics as a product rather than a process. Teachers still use direct learning because it is more practical and easier to achieve learning objectives. As a result, learning is more teacher-centered because the teacher only conveys science lessons as a product, and students memorize the factual information they get (Herayanti et al., 2017; Parno et al., 2019).

In accordance with the character of 21st-century education, physics learning is expected to provide not only students with the ability to master the concepts and principles of physics (basic thinking skills) but also the ability to reason in inductive and deductive analytical thinking (critical thinking skills) (Parno et al., 2021). Teaching and learning is a communication process of exchanging ideas and messages through certain media. In teaching and learning, the teacher provides visualization through images or symbols (Sukirman et al., 2019). Critical thinking skills are essential in this modern era, especially for school students. Critical thinking allows people to be more open-minded, obtain relevant information and find problems and solutions (Yunita et

al., 2018; Vindani et al., 2022). Critical thinking skills lead to students' involvement in finding how to analyze, synthesize, make decisions, build new knowledge and apply it in real life (Rachmantika & Wardono, 2019; Purwati et al., 2020).

In the 2013 curriculum, students are trained in more profound skills related to reasoning. It includes logical, rational, critical, creative, and decision-making (Anggiasari et al., 2018; Mardiki & Virginagoya, 2019). Thinking logically and thinking rationally includes essential thinking, while critical thinking, creative thinking, and making decisions are categorized as complex thinking (Parno et al., 2019; Febrianti et al., 2021). One of the efforts to improve students' critical thinking skills can be through material that is presented contextually. The material can be supported through a learning media that involves the role of technology (Asikin & Daningsih, 2018; Pangestuti et al., 2020). Therefore, we need a learning media that can present material in the form of visual and audio that is real, known as Virtual Reality (VR) (Lv et al., 2017; Salahuddin & Asroriyah, 2019). VR is also a powerful technology for solving today's real-world problems. VR Learning Media has been widely proposed as a significant technological breakthrough with excellent potential to be applied in the world of learning in schools (Sun et al., 2010; Mantasia & Hendra, 2016; Sukirman et al., 2019). One of the benefits of using VR in learning is its potential as a driver of permanent memory for students' learning experiences (retention) (Hastuti et al., 2016; Chou, 2017; Sukaryawan et al., 2019).

Initial observations of physics learning in class XI Science 1 and XI Science 2 1st state SHS Gedeg Mojokerto are as follows. The teacher provides material delivery according to the stages in the 2013 curriculum, but the teacher has never directly given a test to measure students' critical thinking skills. Teachers need to determine whether the learning implemented has stimulated students' critical thinking skills according to the objectives of the 2013 curriculum. Therefore, it is necessary to observe the extent to which students' critical thinking skills are in accordance with critical thinking indicators (Fajiyusni et al., 2017; Varlet et al., 2018; Vinandani et al., 2022). Based on the problems above, this study was conducted to analyze students' critical thinking skills and prior knowledge of STEAM and VR Learning Media for first-state SHS Gedeg in Class XI Science 1 and XI Science 2.

RESEARCH METHOD

This research uses a descriptive qualitative research method. According to Hardani et al. (2020), descriptive research is research conducted to provide facts, events, and symptoms systematically and accurately. Descriptive research does not need to identify the relationship between variables and test a hypothesis. The research was conducted at first state SHS Gedeg, Mojokerto Regency on Thursday, October 6, 2022. The subjects of the research were students of class XI Science 1 and XI Science 2, which amounted to 32 and 33 students, respectively. The object of research is students' critical thinking skills and students prior knowledge about VR Learning Media.

The research technique used in this study is direct measurement and communication techniques using research instruments. Two expert lecturers have validated the instrument used in this research. The instrument's validity and reliability are proper for the research. The data collection technique uses a student critical thinking ability questionnaire that has been adjusted to the critical thinking indicator from Faccione (2015), which is presented in table 1. The score for each statement in the questionnaire is 1 to 4, with 1 indicating the statement is not according to students and 4 indicating the

statement is very suitable for students. In addition, it also uses questions containing several questions about VR Learning Media.

Table 1. Critical thinking indicator.

	Critical Thinking Skills Indicator	Critical Thinking Skills Sub-Indicator
1.	Interpretation	Interpreting the meaning of each element.
2.	Analysis	Analyze the available information to find the relationship between some existing elements. Conduct observations and analyze the results of observations.
3.	Evaluation	Using the right strategy in solving problems.
4.	Explanation	State the results of reasoning in the form of an argument with evidence.
5.	Inference	Making assumptions based on the information obtained Draw conclusions correctly
6.	Self-Regulation	Ability to collaborate with others Able to review the answers that have been given

Facione (2015) in Anggiasari (2018)

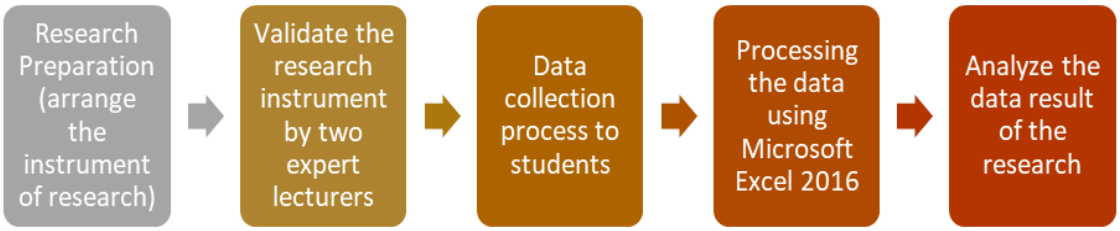

Figure 1. Flowchart of research procedure.

The first stage of the research process is related to research preparation. Preparation includes preparing critical thinking skills questionnaires and questions related to VR learning media. After that, the questionnaire questions were validated by two expert lecturers. The second stage is the data collection process for students of class XI Science 1 and XI Science 2. The third stage is data processing with the help of Microsoft Excel 2016. The percentage of students' critical thinking skills is obtained on each indicator and overall. The formula for measuring the percentage of students' critical thinking skills is as follows:

$$Precentage = \frac{Total\ Score}{Total\ Maximum\ Score}\ x\ 100\%$$

(Razak, 2017)

The next stage is to analyze the percentage of students' critical thinking skills and then determine the category of students' critical thinking skills based on Table 2 of the percentages that have been obtained.

Table 2. Category criteria for students critical thinking skills.

Percentage (%)	Category
76 – 100	High
60 – 75	Medium
0 – 59	Low

(Yunita, 2018)

RESULTS AND DISCUSSION

This study aims to describe the critical thinking skills of students in Class XI MIPA 1 and XI Science 2 at 1st SHS Gedeg, Mojokerto Regency, and students' prior knowledge regarding VR learning media. This is based on the results of student answers in completing the questionnaire and several questions related to VR learning media that have been given. The number of critical thinking skills questionnaires is 20 statements that refer to the critical thinking indicators from Faccione (2015). The statement consists of 20 positive and negative statements. There are 16 positive statements and four negative statements. There are four answer choices, namely SA (Strongly Agree), A (Agree), D (Disagree), and SD (Strongly Disagree) (Parno et al., 2021). The scoring guidelines are outlined in table 3.

Table 3. Critical thinking skills questionnaire scoring guidelines.

Statement Category	Score			
	SA	**A**	**D**	**SD**
Positive Statement	4	3	2	1
Negative Statement	1	2	3	4

The results of the calculations on each statement show the students' abilities on each indicator of critical thinking skills. Each indicator consists of at least 3 statements. Table 4 shows a description of the sub-indicators of students' thinking skills and the percentage of each indicator. Overall, students' average critical thinking ability was obtained at 65.15% in the Medium skill category, according to the description in table 4.

Table 4. Results percentage and category of students' critical thinking skills on each indicator.

	Critical Thinking Skills Indicator	Number of Statement	Percentage	Category
1.	Interpretation	1, 12, 17	66.70%	Medium
2.	Analysis	2, 6, 7, 13, 15	70.00%	Medium
3.	Evaluation	3, 9, 11	62.50%	Medium
4.	Explanation	8, 16, 19	66.70%	Medium
5.	Inference	4, 10, 14	62.50%	Medium
6.	Self-Regulation	5, 18, 20	62.50%	Medium
	Average		**65.15%**	**Medium**

Based on the table, the critical thinking skills of XI Science 1 and XI Science 2 students belong to the medium category. The highest percentage is found in the analysis indicator, which is 70.00%. This shows that students have begun to be able to analyze any available information and know the relationship between elements. Students are also categorized as being able to make observations and analyze the results of the observations they get. Indicators of interpretation and explanation have a percentage of 66.70% in the medium category. This shows that students can interpret the meaning of each element and can state the results of reasoning in the form of arguments and evidence. Students' interpretation and explanation abilities still need to be improved, especially in argumentation. This is evidenced by the need for reasons given to students on questions about VR learning media (Parno et al., 2021). The arguments given by students need to be more scientific and logical. This ability must be further improved through discussion and problem-solving-based learning (Parno et al., 2019; Vinandani et al., 2022).

On the indicators of evaluation, inference and self-regulation have a percentage of 62.50%. This value belongs to the medium category. Evaluation ability includes the use of appropriate strategies in problem-solving. Inference ability includes making assumptions based on the information obtained and being able to conclude things that are analyzed correctly. Self-regulation skills include the ability to collaborate between students and the ability of students to review the answers given. These three capabilities still need to be improved (Vinandani et al., 2022). This ability is crucial for students, especially in everyday life. Students must be able to collaborate with others and evaluate everything that is done (Vinandani et al., 2022).

Table 5. The percentage of students in each category of critical thinking skills.

Critical Thinking Skills Category	Amount of Students	Percentage
High	14	22.00%
Medium	51	78.00%
Low	0	0.00%

Table 5 shows the percentage of students in each category of critical thinking skills. There are no students with the category of students' critical thinking abilities. The number of students in the category of high critical thinking skills is only 14 students, which is 22.00% of the total number of students tested. As many as 78.00% of students, totaling 51, have a moderate critical thinking ability category. This shows that students already have several abilities that are in accordance with the critical thinking indicators as in table 4, namely the ability to analyze. Other abilities still need to be improved so that students' critical thinking skills can reach the high category. These abilities can be trained through learning centered on problem-solving and contextual learning (Parno et al., 2019). The learning carried out must involve students as a whole. Teachers become mentors and facilitators by presenting appropriate learning media to train and improve students' critical thinking skills (Parno et al., 2021).

21st-century learning requires students and teachers to collaborate to form learning activities that involve the use of technology. Technology is one of the crucial tools in supporting the implementation of learning. With information technology, teachers can provide services to students without having to deal directly with them (Jamaludin & Hung, 2017). Likewise, students can obtain information in a broad scope from various sources through virtual space using computers or the internet. The development of technology and the growth of internet use in Indonesia in recent years is thought to have a positive contribution, especially in using internet media for learning (Herayanti et al., 2017).

Learning media can facilitate the learning process and student learning outcomes. In addition, learning media are all tools and materials that can be used for educational purposes, such as radio, television, books, newspapers, magazines, computers, and so on (Hamka & Effendi, 2019). Technology can be a medium that can create and engineer a virtual environment. One technology that can create and engineer the environment is virtual reality (VR) technology. Virtual reality is a technology that can create an immersive virtual environment like real life (real world) (Pangestuti et al., 2020; Parno et al., 2021).

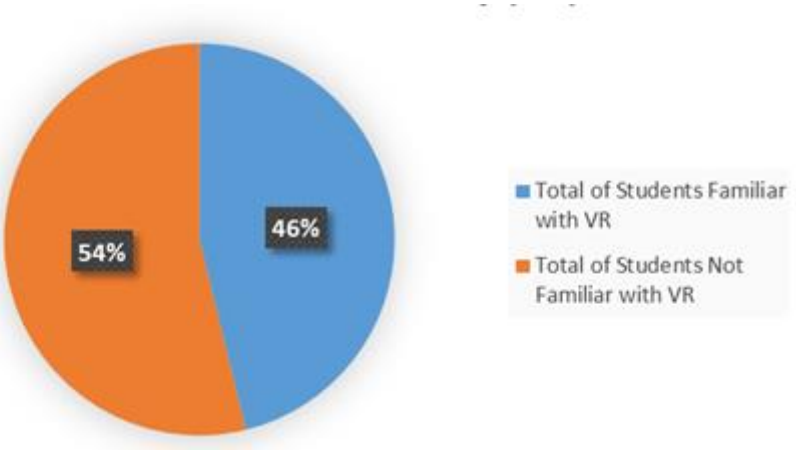

Figure 2. Percentage of student's prior knowledge about VR learning media.

Based on Figure 1, it can be seen that as many as 46.00% (30 students) already know what Virtual Reality (VR) media is. Students know VR as a technology that can present the natural world as a virtual world. Students also know VR as a game device that can be played as if students were directly in the game. As many as 54.00% (35 students) need to learn what VR media is. Based on this, there are still many students who are not familiar with VR media. All students of XI Science 1 and XI Science 2 have never tried and seen firsthand the form of VR media. The students also need to find out if VR media can be used as a means of supporting learning.

So far, the learning media students have encountered are only pictures or props. The students answered that learning that involved learning media would be more interesting and fun for them (Sukirman et al., 2019). However, students also convey that the selected learning media must be adapted to the student's abilities. An active and fun learning atmosphere also depends on the teacher's selection of learning media and mastery of the media. The students argue that, even though learning uses learning media, the teacher must also direct students to understand the material presented so that the learning media used does not feel boring and the material presented can also be understood clearly (Abdussalam et al., 2018).

Based on the answers of class XI Science 1 and XI Science 2 students, they are very enthusiastic if they can later take part in physics learning using VR learning media. They assume that the physics material, which was initially only identical with formulas and calculations, will be more fun and easy to understand if it is connected with everyday life's phenomena. The students thought that learning physics using VR would feel more natural and provide an exciting experience for students. In addition, students think that learning using VR learning media can train students' abilities in using technology to support their learning activities (Abdillah et al., 2018).

It is necessary to develop VR learning media in physics learning to provide an interesting and fun learning experience for students of Class XI Science 1 and XI Science 2 1st SHS Gedeg. The VR learning media is expected to improve students' critical thinking skills, which were previously still in the medium category to be upgraded to a high category. Innovation in learning activities for class XI Science and XI Science 2 is needed, which can involve information technology. With these activities, in addition to understanding the material contextually, students can also improve their ability to choose and use information technology to support their learning process (Agushinta & Satria, 2018; Arsadhana, 2022).

CONCLUSION

Based on the explanation of the discussion, it can be concluded that the critical thinking ability of students of class XI Science 1 and XI Science 2 of 1st SHS Gedeg, Mojokerto Regency for all indicators is in the moderate category. The indicator of analytical ability has the highest percentage, in the medium category. The number of students with critical thinking skills in the high category is 14, and in the medium category, as many as 51 students. As many as 54.00% of students do not know about VR learning media and as many as 46.00% of students already know VR learning media. Based on the results of questions regarding VR learning media, students showed interest in learning using VR. Students assume that by using VR learning media that can present fundamental physics concepts in the phenomena of everyday life, they can learn physics more fun. Students' critical thinking skills can be improved through contextual learning using VR learning media. Problem-based learning or Problem-Based Learning is appropriate learning to improve students' critical thinking skills. Teachers can use VR media as a means of introducing information technology to students as well as a means of delivering material in physics learning. In using VR media in learning activities, teachers must continue to actively guide students, direct students to use VR, and understand the material presented on VR media well.

REFERENCES

Abdillah, F., Riyana, C., & Alinawati, M. (2018). Pengaruh penggunaan media virtual reality terhadap kemampuan analisis siswa pada mata pelajaran IPA kelas VIII SMP. *Edutechnologia, 2*(1), 35-44.

Abdussalam, A., Sulthoni, S. & Munzil, M. (2018). Media virtual reality tata surya untuk meningkatkan kemampuan retensi. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan, 3*(9), 1160-1167. http://dx.doi.org/10.17977/jptpp.v3i9.11527

Agushinta, R. D., & Satria, A. (2018). Pembelajaran 3D sistem ekskresi manusia berbasis virtual reality dan android. *Jurnal Teknologi Informasi dan Ilmu Komputer, 5*(4), 381-388. http://dx.doi.org/10.25126/jtiik.201854665

Anggiasari, T. S., Hidayat, H., & Harfian, B. A. A. (2018). Analisis keterampilan berpikir kritis siswa SMA di kecamatan kalidoni dan ilir timur II. *Bioma, 7*(2), 183-195. https://doi.org/10.26877/bioma.v7i2.2859

Arsadhana, I. W. A. S., Dewi, N. K. R. S., & Putri, N. K. J. K. (2022). Aplikasi pembelajaran berbasis virtual reality sebagai inovasi pendidikan berkelanjutan di era society 5.0. *Prosiding Webinar Nasional Pekan Ilmiah Pelajar (PILAR)*, 736-740.

Asikin, N., & Daningsih, E. (2018). Development audio-visual learning media of hydroponic system on biotechnology topic for senior high schools. *Advances in Social Science, Education and Humanities Research,* 174-181. https://dx.doi.org/10.2991/ice-17.2018.44

Chou, C. C. (2017). An analysis of the 3D video and interactive response approach effects on the science remedial teaching for fourth grade underachieving students. *Eurasia Journal of Mathematics, Science and Technology Education, 13*(4), 1059–1073. https://doi.org/10.12973/eurasia.2017.00658a

Fajiyusni, J. F., Masriani, M., Rasmawan, R. (2017). Deskripsi keterampilan berpikir kritis siswa pada materi minyak bumi kelas XI MIA 3 SMAN 4 pontianak. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa,* 6(10), 1-11. http://dx.doi.org/10.26418/jppk.v6i10.22274

Febrianti, N. S., Utomo, A. P., & Supeno. (2021). Kemampuan berpikir kritis siswa SMP dalam pembelajaran IPA menggunakan media aplikasi android getaran dan gelombang. *OPTIKA: Jurnal Pendidikan Fisika*, *5*(1), 26-33. https://doi.org/10.37478/optika.v5i1.936

Hamka, D., & Effendi, N. (2019). Pengembangan media pembelajaran blended learning berbasis edmodo pada mata kuliah fisika dasar di program studi pendidikan IPA. *Journal of Natural Science and Integration, 2*(1), 19-33. http://dx.doi.org/10.24014/jnsi.v2i1.7111

Hardani, N. J. Auliya, H., Andriani, E. A., Fardani, J., Ustiawaty, E. F., Utami, D. J., Sukmana, S., & Istiqomah, R. R. (2020). *Metode penelitian kualitatif & kuantitatif*. Pustaka Ilmu.

Hastuti, A., Sahidu, H., & Gunawan, G. (2016). Pengaruh model PBL berbantuan media virtual terhadap kemampuan pemecahan masalah fisika. *Jurnal Pendidikan Fisika dan Teknologi, 2(*3), 129-135. https://doi.org/10.29303/jpft.v2i3.303

Herayanti, L., Fuadunnazmi, M., & Habibi, H. (2017). Pengembangan media pembelajaran berbasis moodle pada mata kuliah fisika dasar. *Cakrawala Pendidikan, 36*(2), 210-219. https://doi.org/10.21831/cp.v36i2.13077

Amri, I., Syuhendri, S., Wiyono, K. (2015). Pengembanngan media pembelajaran e-learning berbasis web untuk mata kuliah fisika inti. *Jurnal Inovasi dan Pembelajaran Fisika, 2*(1), 25-36. https://doi.org/10.36706/jipf.v2i1.2351

Jamaludin, A., & Hung D. (2017). Problem-solving for STEM learning: Navigating games as narrativized problem spaces for 21st century competencies. *Research and Practice in Technology Enhanced Learning, 12*(1), 1–14. http://dx.doi.org/10.1186/s41039-016-0038-0

Lv, Z., Li, X. & Li, W. (2017). Virtual reality geographical interactive scene semantics research for immersive geography learning. *Neurocomputing, 254,* 1339–1351. https://doi.org/10.1016/j.neucom.2016.07.078.

Mantasia, M., & Hendra, J. (2016). Model pembelajaran berbasis virtual sebagai upaya mitigasi dan proses adaptasi terhadap bencana alam di SMP. *Jurnal Penelitian Pendidikan Paedagogia, 19*(1), 1-14. https://doi.org/10.20961/paedagogia.v19i1.36089

Mardiki, S., & Virginagoya, H. (2019). Pengembangan media virtual reality pada muatan pelajaran IPA kelas VI sekolah dasar. *Jurnal Teknologi Pendidikan, 21*(3), 241-255. https://doi.org/10.21009/jtp.v21i3.13025

Pangestuti, T. M., Kamil, M., & Sardin, S. (2020). Model pelatihan adragogi berbasis media *virtual reality* dalam peningkatan kesiapsiagaan bencana. *Indonesian Journal of Adult and Community Education, 2*(1), 38-42. https://doi.org/10.17509/ijace.v2i1.28289

Parno, P., Yuliati, L., & Ni'mah, B. Q. A. (2019). The influence of PBL-STEM on students' problem solving skills in the topic of optical instruments. *Journal of Physics: Conference Series, 1171*(1), 1-9. http://dx.doi.org/10.1088/1742-6596/1171/1/012013

Parno, P., Fauziyah, S., Pramono, N. A., Anggraini, R. T., Hidayat, A., Supriana, E., & Ali, M. (2021). The increase of students' critical thinking abilities on optical instrument topic through PBL-STEM with virtual simulation media. *Journal of Physics: Conference Series, 1918*, 1-8. https://doi.org/10.1088/1742-6596/1918/5/052067

Parno, P., Anggraini, R. T., Hidayat, A., Fauziyah, S., Pramono, N. A., Supriana, E., & Ali, M. (2021). The building of students' problem solving skills through stem approach with virtual simulation media. *Journal of Physics : Conference Series "ICOSETH 2020", 1842*, 1-12. https://doi.org/10.1088/1742-6596/1842/1/01/2073

Paul, R., & Elder, L. (2008). *The miniature guide to critical thinking "concepts & tools"*. The Foundation of Critical Thinking.

Prayudha, I. P. A., Wiranatha, A. A. K. A. C., & Raharja, I. M. S. (2017). Aplikasi virtual reality media pembelajaran sistem tata surya. *Jurnal Ilmiah Merpati (Menara Penelitian Akademika Teknologi Informasi), 5*(2), 72-80. https://doi.org/10.24843/JIM.2017.v05.i02.p08

Purwati, Y., Selvi, S., Fandy, S. U., & Wiga, M. B. (2020). Pengembangan media pembelajaran tata surya berbasis virtual reality untuk siswa kelas 6 sekolah dasar dengan evaluasi kepuasan pengguna terhadap elemen multimedia. *Jurnal Tekonologi Informasi dan Ilmu Komputer, 7*(2), 259-266. http://dx.doi.org/10.25126/jtiik.2020701894

Rachmantika, A., & Wardono, R. (2019). Peran kemampuan berpikir kritis siswa pada pembelajaran matematika dengan pemecahan masalah. *PRISMA, Prosiding Seminar Nasional Matematika, 2*, 439-443.

Razak, F. (2017). Hubungan kemampuan awal terhadap kemampuan berpikir kritis matematika pada siswa kelas VII SMP pesantren immim putri minasatene. *Moshrafa*, *6*(1), 117-128. https://doi.org/10.31980/mosharafa.v6i1.299

Salahuddin, M., & Asroriyah, F. (2019). Kecakapan berpikir dalam konteks pedekatan pembelajaran pada kurikulum sekolah di indonesia. *Jurnal Al-Adabiya, 14*(1), 63-84. https://doi.org/10.37680/adabiya.v14i01.104

Sukaryawan, I. M., Sugihartini, I. N., & Ardwi, P. (2019). Pengaruh penggunaan media virtual reality terhadap hasil belajar anak kelompok B pada tema pengenalan binatang buas. *Jurnal Pendidikan Teknologi dan Kejuruan, 16*(1), 118-128. https://doi.org/10.23887/jptk-undiksha.v16i1.16978

Sukirman, S., Reza, W. A., & Sujalwo, S. (2019). Media interaktif berbasis virtual reality untuk simulasi bencana alam gempa bumi dalam lingkungan maya. *Khazanah Informatika: Jurnal Ilmu Komputer dan Informatika, 5*(1), 99-107. https://doi.org/10.23917/khif.v5i1.8054

Sun, K. T., Lin, C. L., & Wang, S. M. (2010). A 3-D virtual reality model of the sun and the moon for e-learning at elementary schools. *International Journal of Science and Mathematics Education, 8*(4), 689–710. https://doi.org/10.1007/s10763-009-9181-z

Varlet, M., Filippeschi, A.,Ben-sadoun, G., Ratto, M., Marin, L., Ruffaldi, E., & Bardy, B. G. (2018). Virtual reality as a tool to learn interpersonal coordination: Example of team rowing. *Presence, 22*(3), 202–215. https://doi.org/10.1162/PRES_a_00151

Vinandani, M., Zainur, R. R., & Supeno, S. (2022). Identifikasi kemampuan berpikir kritis pada pembelajaran IPA siswa SMP negeri 1 glenmore kabupaten banyuwangi. *Jurnal Saintifika, 24*(1),20-29. https://doi.org/10.21009/10.21009/JPD.081

Yunita, A., Rohiat, S., & Amir, H. (2018). Analisis kemampuan berpikir kritis mata pelajaran kimia pada siswa kelas XI IPA SMAN 1 kepahing. *Jurnal Pendidikan dan Ilmu Kimia*, *2*(1), 33-38. https://doi.org/10.33369/atp.v2i1.4628

*__Faradila Aulia' Alifteria (Corresponding Author)__
Science Education Study Program of Postgraduate Program,
State University of Surabaya,
Jl. Lidah Wetan, Surabaya, East Java, 60213, Indonesia
Email: faradila.21025@mhs.unesa.ac.id

Prof. Tjipto Prastowo, Ph.D.
Department of Physics Faculty of Science and Mathematics,
State University of Surabaya,
Jl. Ketintang, Surabaya, East Java, 60231, Indonesia
Email: tjiptoprastowo@unesa.ac.id

Prof. Nadi Suprapto, Ph.D.
Department of Physics Faculty of Science and Mathematics,
State University of Surabaya,
Jl. Ketintang, Surabaya, East Java, 60231, Indonesia
Email: nadisuprapto@unesa.ac.id