JIPF (JURNAL ILMU PENDIDIKAN FISIKA)
p-ISSN: 2477-5959 | e-ISSN: 2477-8451 *Vol. 8 No. 3, September 2023, Page 278-286*

Enhancing Creative Thinking Skills through Project-Based Learning Assisted Game Open Online Physics Instructional

Firmanul Catur Wibowo [1*)], Nur Jahan Ahmad [2]
Universitas Negeri Jakarta, Indonesia[1], Universiti Sains Malaysia, Malaysia[2]
[*)]Corresponding E-mail: fcwibowo@unj.ac.id

Received: December 7th, 2022. Revised: March 15th, 2023. Accepted: June 14th, 2023

Keywords :
Creative Thinking Skills (CTS); Project-Based Learning (PjBL); Game Open Online Physics Instructional (GOOPI)

ABSTRACT
This study aims to enhance creative thinking skills through Project-Based Learning (PjBL) assisted Game Open Online Physics Instructional (GOOPI). GOOPI is an online game-based physics learning media and contains physics concepts found on the page: https://goopi.id/ (use UC browser). The research method used is a quasi-experimental design with two experimental groups and one control group. The sample of this study was 75 eighth grade students from a province in Indonesia. GOOPI technology as software developed to support PjBL activities in the classroom. The results of the research show that project-based learning assisted GOOPI can enhance creative thinking skills. Based on statistical calculations there is an increase in the gain value, an increase of 0.72 in the high category for the PjBl experimental group 1 with GOOPI, the PjBl experimental group 2 alone experienced an increase in the gain value of 0.55 in the medium category, and the group with the teacher based instructional method experienced an increase in the gain value of 0, 45 medium categories. It is suggested that GOOPI technology can be an interesting and effective tool to activate students' positive interest in the PJBL process. In addition, the implications of applying GOOPI for physics learning and recommendations for further study are discussed in this study.

INTRODUCTION

Natural Sciences is a subject related to how to find out about nature systematically [1], so that science is not only the mastery of a collection of knowledge in the form of facts, concepts, or principles but also a process of discovery [2]. Science, which is a basic science developed based on the results of scientific discoveries related to natural events that occur in everyday life [3]. In accordance with its nature, the orientation of science learning is more towards inculcating knowledge about basic concepts [4], developing scientific skills, and developing thinking skills [5], as scientists formulate laws and principles [6]. Science is a collection of knowledge and processes, it of knowledge and ways to obtain and use that knowledge [7]. Science is a product and process that cannot be separated [8]. Real

Science is both product and process, inseparably Joint which is used to strengthen the planting of science concepts [9].

Science as a process refers to the steps taken by scientists to conduct investigations to find explanations about natural phenomena [10]. These steps include formulating problems, formulating hypotheses, designing experiments, collecting, and analysing and finally concluding [11]. From this it appears that the fundamental characteristic of science is quantification, meaning that natural phenomena can be in the form of quantities [12]. Groups of science subjects, including physics, are held in schools to introduce science, both processes and products to students. Physics education is expected to be a vehicle for students to learn about themselves and the environment, as well as prospects for further development of its application in everyday life [13] [14].

The objectives of learning physics are so that students have the ability to: 1) Develop an understanding of various natural phenomena, concepts, and principles of science that are useful and can be applied in everyday life [15]; 2) Develop curiosity, positive attitude, and awareness of the interplay between science, environment, technology, and society [16]; 3) Improving knowledge, concepts, and thinking skills as the basis for continuing education to the next level [17]; 4) Conduct scientific inquiry to foster the ability to think, behave, and act scientifically and communicate [18]. For physics subjects in schools to meet the demands in achieving the goals described above, it is undeniable that physics learning must be constructed in such a way that the education and training process for these various competencies can occur in the process [19].

This kind of learning process also occurred in one city in Jakarta, which was observed by researchers when conducting direct observations of the learning process carried out by a physics teacher at the school, indicating that the physics learning process was dominated by the online lecture method. Learning with this method is teacher-cantered and emphasizes the process of transferring knowledge from teachers to students so that it does not facilitate students to be active in developing thinking skills through the process of inquiry to find concepts [20]. Learning with the lecture method does not meet the demands of the current science subject objectives. The demands of science education, in this case physics, are not only to increase knowledge and concepts, but also to improve students' thinking skills. Learning with traditional methods has an impact on the low motivation and learning outcomes obtained by students. In connection with these problems, it is necessary to improve the learning process so that students are actively involved in the process of scientific investigation directly to increase motivation and learning outcomes. Physics learning that only displays science products in the form of complicated physics formulas will make students tend to be afraid and dislike physics [21].

Physics has underpinned the development of various technological products that facilitate human life [22]. However, this is rarely communicated to students. It is rare for classroom learning to link the concepts being studied with technological products that have been developed based on the concepts studied. Most of them are not aware that the technology products they use are basically physics concepts that they are learning [23]. In learning also rarely invites students to learn to apply the physics concepts learned in making a work. Whereas when students know that the physics concepts, they learn are very useful and have a big role in developing various technological products, then of course students' motivation to study physics will grow.

One learning model that presents challenges in the form of project assignments at the beginning of learning is a project-based learning model. For example, the project of making a simple water flask, the project of making a simple fan, the project of designing the electrical installation of a building as desired, and so on. The project-based learning model presents five stages of learning, The first stage is the presentation of project assignments, at this stage the teacher proposes project assignments as a basis for challenges or motivation to students [24]. The second stage is organizing students to learn, students in one class are divided into several small groups. Furthermore, the third stage is planting an understanding of the concept, the process can be through experimental activities. The fourth stage is the creation and presentation of project tasks. As the name implies, at this stage students work on project assignments and present the results in front of the class for evaluation. The fifth stage is

reinforcement and follow-up learning. At this stage the teacher reflects on the implementation of project-based learning, students work on practice questions and the teacher gives structured tasks in the form of enrichment and strengthening of conceptual understanding through reading literature from the internet about the application of the concepts of Heat in everyday life [25].

Moreover, if this project-based learning is assisted with online game media in the form of GOOPI, it will make students more challenged and interesting for students [26]. During a pandemic like this, it is necessary to innovate learning media that can train and embed physics concepts in a fun way. The advantages of GOOPI include, being accessible online from anywhere, easy to operate and use in physics learning, facilitating students to learn while playing through online games, challenging students to learn because there are missions 1 mission 2 and mission 3 that must be completed to become winners [27].

However, the implementation of physics learning that occurs in the field is still very far from what the curriculum expects. The results of the preliminary study conducted by the researcher showed that first, the physics learning carried out in the schools studied were generally still traditional in nature, where learning tended to be teacher-cantered with the process tending to transfer knowledge; second, the average achievement of students' physics learning outcomes in the evaluated aspects is low, even at the cognitive level. This situation has made students seem bored and bored with learning physics and in the end their interest and motivation to learn physics tends to decrease; third, the learning process carried out in the classroom is more often dominated by the teacher and does not facilitate students to be active in the process of finding concepts [28].

The use of project-based learning models in physics learning has been carried out by several researchers. Project-based learning can be the development of thinking skills and understanding the other science. Project-Based Learning Assisted by Online Games helps students in developing thinking skills and increasing understanding of concepts. Based on the background that has been stated above, the formulation of the problem in this research is Enhancing Creative Thinking Skills Through Project-Based Learning Assisted Game Open Online Physics Instructional.

METHOD

Participant

Participants A total of 75 students (aged 16 to 17 years, M = 14.02, SD = 0.52) from three classes of tenth graders at a high school in a province located in one of the provinces in Jakarta, Indonesia. Of the students, 30 were male and 45 were female. Prior to the experiment, the three classes were randomly divided into two experimental groups and one control group, which consisted of 25 students in the Experimental Group 1, 25 students in the Experimental Group 2 and 25 students in the Control Group. These groups did not differ in terms of the average value of learning achievement scores for physics courses in the semester of the 2019–2020 school year, based on the results of the one-way ANOVA test F (72) = 2.82; p> .05. sample selection is done by purposive sampling, namely the technique of determining the sample with certain considerations. The consideration for choosing the class as the research sample was because it was based on information from the physics teacher at the school that the activity, learning response, enthusiasm, and participation of class X students in learning physics were quite good, so the research process was expected to run smoothly without many technical obstacles such as poor students. Seriously, students are less enthusiastic and tend to be playful.

Procedure

This study uses a quasi-experimental procedure that includes the design of the experimental and control groups before and after the pre-test and post-test. The experiment lasts for 8 weeks in the even semester of the 2019-2020 academic year, learning is carried out for 2-3 hours per week. For more details, the research method carried out is shown in Figure 1.

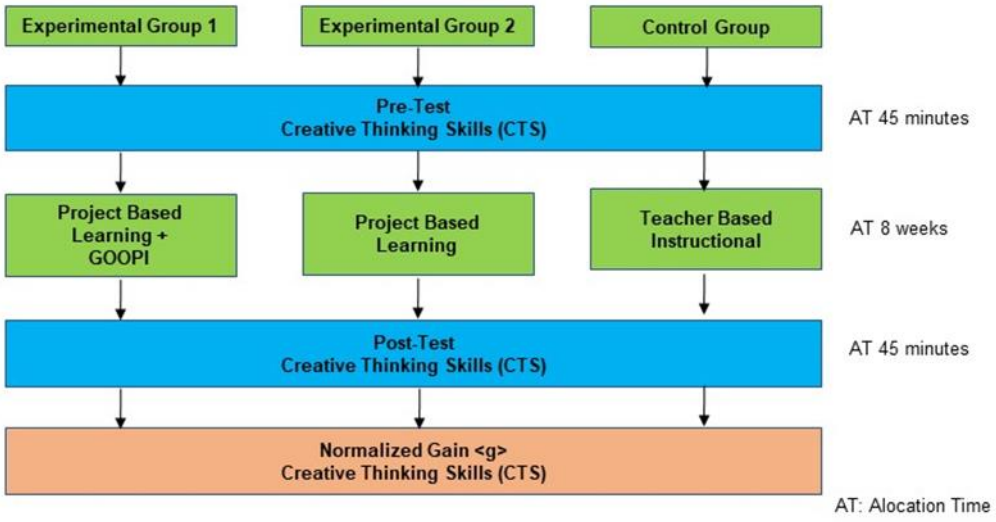

Fig 1. *Procedure Experiment*

Based on Figure 1, information is obtained that in this study using 3 groups, the first group was experimental group 1 with project-based learning (PjBL) assisted by GOOPI. Experimental group 2 with project-based learning (PjBl) and control group using teacher based instructional. Learning that is applied to the concept of heat transfer in physics subjects.

Instruments

Creative Thinking Skills Test includes questioning skills, skills in guessing the causes of an event, skills in guessing the consequences of an event, and skills in improving output related to heat material. Creative thinking skills tests are constructed in the form of a written test type of description test. Creative thinking skills test is given. twice, namely at the beginning (pre-test) and at the end (post-test) before treatment and after treatment. This test aims to measure creative thinking skills before and after the treatment is given. The initial test is used to see the initial conditions of the research subjects related to creative thinking skills. The results of this test will calculate the normalized gain <g> used to see what improvements in creative thinking skills can be developed through the application of project-based physics learning.

Normalized Gain <g>

In general, data processing is carried out using the help of a statistical hierarchical approach. Primary data on student test results before and after treatment were analyzed by comparing the scores of the initial and final tests. The increase that occurs before and after learning is calculated by the gain factor formula (g) developed by Hake with the normalized gain score average formula <g>. The increase in cognitive learning outcomes and creative thinking skills of the concept of Heat by students developed through learning is calculated based on the average gain score normalized <g> [29] [30].

$$< g >= \frac{< S_{post} > - < S_{pre} >}{< S_{maks} > - < S_{pre} >} \quad (1)$$

Information:

$<S_{post}>$ = average final test score
$<S_{pre}>$ = mean initial test score
$<S_{max}>$ = maximum average score

After obtaining a score of <g>, then the categorization is carried out through the normalized Gain Criteria as shown in Table 1.

Table 1. Normalized Gain Criteria

<g>	Criteria
g ≥ 0,7	High
0,3 ≤ g < 0,7	Middle
g < 0,3	Low

Normalized Gain Criteria test results to measure students' creative thinking skills improvement. These results will have an impact on the implementation of GOOPI for physics learning in order to build a comprehensive physics concept on the concept of heat transfer. In addition, this increases of <g> provides an illustration of how much the creative thinking skills increase in each student.

RESULTS AND DISCUSSIONS

Game Open Online Physics Instructional

The GOOPI is a physics learning media on the concept of heat transfer that can be accessed for free and anywhere. Media used in this study is the result of its development by researchers for nearly 3 years begin 2019 in the multimedia laboratory of the Universitas Negeri Jakarta, Indonesia. Researchers from Physics Education Research (PER) conducted a series of studies to explore the working principles of GOOPI (Open Online Physics Instructional Game) as a physics learning environment, and it is available for free on the following page: https://goopi.id/ (UC Browser) [8] [9]. The features of GOOPI are shown in Figure 2.

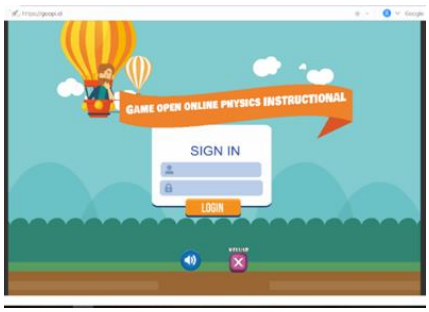

Fig 2. *GOOPI https://goopi.id/ (UC Browser)*

Figure 2 shows the start page of GOOPI, this page can be accessed on the https://goopi.id/ with use UC Browser. To sing in, you let go submit a user and password, the user "physics" and the password is "123". When registering the user and password, click login to register. There is as well a volume button going on this site if you want to silent the sound. Doubt the students can answer, the Finish button seems, and they let go advance to the Mission of 3 menu displayed in Figure 3.

Fig 3. *GOOPI Display on Mission 1 Conduction*

Mission 3 this GOOPI menu is conduction, convection dan the last menu radiation. Based on figure 3 according to menu 1, menu 2 and menu 3 for more details, information is obtained that mission 1 is an online physics game involving heat transfer activities in the conduction between aluminum and copper metals when heated by Bunsen. Click the start button to complete this task and the game process will be displayed by GOOPI showing microscopic transmission. Figure 4 is mission 2 which contains an online game that contains the concept of convection as shown in the picture.

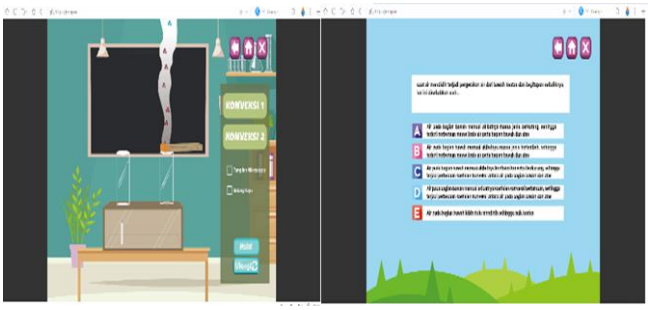

Fig 4. *GOOPI Display on Mission 2 Convection*

Figure 4 provides information about the convection process; this process is a transfer of heat through a flow in which the intermediate substance also moves. If the particles move and cause heat to propagate, convection occurs, convection occurs in liquids and gases (air / wind) as shown in the figure. Figure 5 is mission 3 which contains an online game that contains the concept of radiation as shown in the picture.

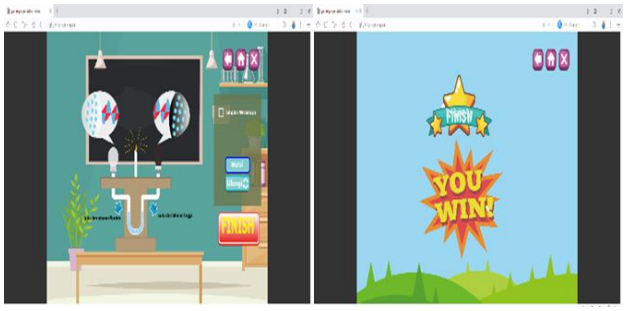

Fig 5. *GOOPI Display on Mission 3 Radiation*

Based on Figure 5. Information obtained that the GOOPI process of radiation, The transfer of heat without an intermediate is radiation, radiation is the transfer of heat without an intermediary. The black and white light bulb can be displayed by GOOPI by showing the microscopic movement of particles during the radiation process. The advantage of GOOPI is that it can visualize microscopic physical material or phenomenon. The characteristics of physics learning for concept formation are physics learning where there is a process of creating a physics concept from the initial state of not understanding the concept to understanding the concept. Therefore, real steps in the process are needed that can structure knowledge and correct (reconstruct) concepts if it is not suitable for the scientific context [11].

Creative Thinking Skills (CTS)

Students' creative thinking skills were assessed from the answers to the students' pre-test and post-test after participating in project-based physics learning. Students' thinking skills for each activity can be seen from the results of the test scores obtained by students on each item given in the initial and final tests that test for each activity of creative thinking skills. The number of questions used consists of 10 items, all of which are in the form of descriptions, which test the four activities included in creative thinking skills. Specifically, the indicators of creative thinking skills assessed in this study focused on

four creative thinking skills activities. The four activities are: (1) questioning activity, (2) guessing the causes of an event, (3) guessing the consequences of an event, and (4) activity of improving the output. Creative Thinking Skills Test includes questioning skills, skills in guessing the causes of an event, skills in guessing the consequences of an event, and skills in improving output related to heat material. Creative thinking skills tests are constructed in the form of a written test type of description test. The results of the assessment of creative thinking skills in the form of the average score of students.

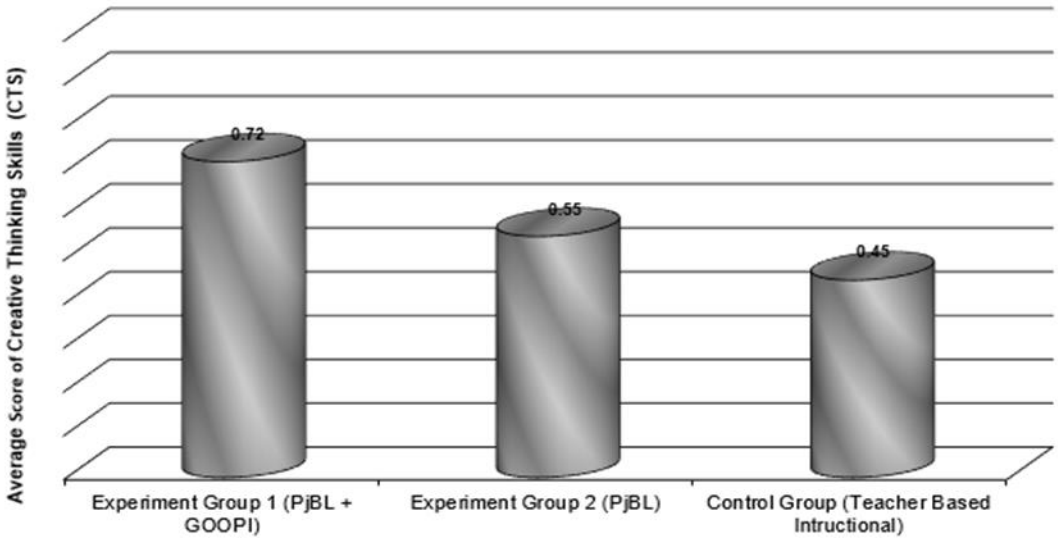

Fig 6. *Pre-test Average, Post-test Average, and Normalized Average Gain Score <g> CTS*

Based on Figure 6 information obtained that the average score of the initial test, the average score of the final test and the average score of the normalized gain score <g>. Based on statistical calculations there is an increase in the gain value, an increase of 0.72 in the high category for the PjBl experimental group 1 with GOOPI, the PjBl experimental group 2 alone experienced an increase in the gain value of 0.55 in the medium category, and the group with the teacher based instructional method experienced an increase in the gain value of 0, 45 medium categories.

The increase in each activity of creative thinking skills can be seen from the results of the test scores obtained by students on each item given in the initial test and final test that tests for each activity of creative thinking skills. The number of questions used consists of 10 questions, all of which are in the form of descriptions. The average score of the initial test, and the average final test of students' creative thinking skills on the concept of heat transfer. The lowest average score for creative thinking skills in the experimental group 1 when the students' initial test occurred in the questioning activity was 0.20 from the ideal score 6. The average score for the creative thinking skill initial test in the activity to improve the output was 1.12 from ideal score 3. The average score of the initial test of creative thinking skills in guessing activities due to an event is 2.41 from the ideal score 6. The highest average score for creative thinking skills occurs in guessing activities because of an event of 5.59 from the ideal score 15. The lowest average score of creative thinking skills in the experimental group 1 at the time of the final test occurred in the activity of improving the output of 1.97 from the ideal score 3. The average score of the final test of creative thinking skills on the questioning activity was 4.09 ideal 6. The average score of the final test of creative thinking skills in guessing activities due to an event is 4.15 from the ideal score of 6. The highest average score for the final test occurred in the guessing activity for an event of 9.50 out of an ideal score of 15.

CONCLUSION AND SUGGESTION

Enhancing Creative Thinking Skills through Project-Based Learning Assisted GOOPI in the high category 1 experimental group was influenced by students working on project assignments according to the project assignment guide. Students are accustomed to doing projects and planting the concept of concept transfer through a GOOPI Online Game. So that students tend to be interested and ask the teacher a lot to strengthen the concepts being taught. The application of the project-based physics learning model assisted by GOOPI can improve students' creative thinking skills (CTS) the concept of heat transfer. This is indicated by the normalized average gain score in the experimental group 1 which is included in the high category. In general, there is an increase in the average gain score normalized <g> for each creative thinking skill activity. It is suggested that GOOPI technology can be an interesting and effective tool to activate students' positive interest in the PJBL process. In addition, the implications of applying GOOPI for physics learning and recommendations for further study are discussed in this study.

ACKNOWLEDGMENTS

Thank you to LPPM UNJ for providing research assistance and community service in 2023, Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, Indonesia.

REFERENCES

[1] Garzón, J., Pavón, J., & Baldiris, S. (2019). Systematic review and meta-analysis of augmented reality in educational settings. *Virtual Reality*, *23*(4): 447-459.
[2] Wilberding, E. (2021). *Teach like socrates: Guiding socratic dialogues & discussions in the classroom*. Routledge.
[3] Bryan, C. J., Tipton, E., & Yeager, D. S. (2021). Behavioural science is unlikely to change the world without a heterogeneity revolution. *Nature human behaviour*, *5*(8): 980-989.
[4] Lestari, H., Ali, M., Sopandi, W., Wulan, A. R., & Rahmawati, I. (2022). The Impact of the RADEC Learning Model Oriented ESD on Students' Sustainability Consciousness in Elementary School. *Pegem Journal of Education and Instruction*, *12*(2): 113-122.
[5] Rashidov, A. S. (2022). Using Of Problem Educational Technologies In The Development Of Students'creative And Logical Thinking Skills. *Berlin Studies Transnational Journal of Science and Humanities*, *2*(1.5 Pedagogical sciences).
[6] Drivdal, L., & van der Sluijs, J. P. (2021). Pollinator conservation requires a stronger and broader application of the precautionary principle. *Current opinion in insect science*, *46*: 95-105.
[7] Hong, R., Xiang, C., Liu, H., Glowacz, A., & Pan, W. (2019). Visualizing the knowledge structure and research evolution of infrared detection technology studies. *Information*, *10*(7): 227.
[8] Wei, J., Chu, X., Sun, X. Y., Xu, K., Deng, H. X., Chen, J., ... & Lei, M. (2019). Machine learning in materials science. *InfoMat*, *1*(3): 338-358.
[9] Mukhamedov, G., Khodjamkulov, U., Shofkorov, A., & Makhmudov, K. (2020). Pedagogical education cluster: content and form. *ISJ Theoretical & Applied Science*, *1*(81): 250-257.
[10] Pellas, N., Mystakidis, S., & Kazanidis, I. (2021). Immersive Virtual Reality in K-12 and Higher Education: A systematic review of the last decade scientific literature. *Virtual Reality*, *25*(3): 835-861.
[11] Supena, I., Darmuki, A., & Hariyadi, A. (2021). The Influence of 4C (Constructive, Critical, Creativity, Collaborative) Learning Model on Students' Learning Outcomes. *International Journal of Instruction*, *14*(3): 873-892.
[12] Pramono, J., Kusumastuti, D., Sekarwangi, M., & Choerudin, A. (2020). The Community Participation in Disaster Mitigation to Managing the Impact of Natural Disasters in Indonesia. *Journal of Talent Development and Excellence*, *12*: 2396-2403.
[13] Fidan, M., & Tuncel, M. (2019). Integrating augmented reality into problem based learning: The

effects on learning achievement and attitude in physics education. *Computers & Education*, *142*: 103635.
[14] Wibowo, F. C., Darman, D. R., Prahani, B. K., & Faizin, M. N. (2022, November). Optics Virtual Laboratory (OVL) Based on Physics Independent Learning (PIL) For Improving Critical Thinking Skill. In *Journal of Physics: Conference Series* (Vol. 2377, No. 1, p. 012077). IOP Publishing.
[15] Carleo, G., Cirac, I., Cranmer, K., Daudet, L., Schuld, M., Tishby, N., ... & Zdeborová, L. (2019). Machine learning and the physical sciences. *Reviews of Modern Physics*, *91*(4): 045002.
[16] Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, A. (2020). The effective components of creativity in digital game-based learning among young children: A case study. *Children and Youth Services Review*, *116*: 105227.
[17] Arnellis, A., Fauzan, A., Arnawa, I. M., & Yerizon, Y. (2020, May). The effect of realistic mathematics education approach oriented Higher order thinking skills to achievements' calculus. In *Journal of Physics: Conference Series* (Vol. 1554, No. 1, p. 012033). IOP Publishing.
[18] Tanti, T., Kurniawan, D. A., Sukarni, W., Erika, E., & Hoyi, R. (2021). Description of student responses toward the implementation of problem-based learning model in physics learning. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *6*(1): 30-38.
[19] Astalini, A., Kurniawan, D. A., Sari, D. K., & Kurniawan, W. (2019). Description of scientific normality, attitudes of investigation and interested career on physics in senior high school. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *4*(2): 56-63.
[20] Wahyudi, W., Verawati, N. N. S. P., Ayub, S., & Prayogi, S. (2019). The effect of scientific creativity in inquiry learning to promote critical thinking ability of prospective teachers. *International Journal of Emerging Technologies in Learning (Online)*, *14*(14): 122.
[21] Dávila-Acedo, M. A., Cañada, F., Sánchez-Martín, J., Airado-Rodríguez, D., & Mellado, V. (2021). Emotional performance on physics and chemistry learning: the case of Spanish K-9 and K-10 students. *International Journal of Science Education*, *43*(6): 823-843.
[22] Farmonov, U. (2020). Teaching of physics for students of natural direction with innovation technologies. *Физико-технологического образование*, (1).
[23] Madni, A. M., Madni, C. C., & Lucero, S. D. (2019). Leveraging digital twin technology in model-based systems engineering. *Systems*, *7*(1): 7.
[24] Dewi, W. S., & Sari, S. Y. (2022, July). The validity of physics learning evaluation teaching material based on project-based learning and portfolio assessment. In *Journal of Physics: Conference Series* (Vol. 2309, No. 1, p. 012082). IOP Publishing.
[25] Sagala, R., Rofiqul, U. M. A. M., Thahir, A., Saregar, A., & Wardani, I. (2019). The effectiveness of stem-based on gender differences: The impact of physics concept understanding. *European Journal of Educational Research*, *8*(3): 753-761.
[26] Wibowo, F. C., Nasbey, H., Sanjaya, L. A., Darman, D. R., Gumala, Y., Adityo, F. P., & Budi, A. S. (2021, March). Game Open Online Physics Instructional (GOOPI) for technology improving 21st-century careers. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1098, No. 3, p. 032079). IOP Publishing.
[27] Wibowo, F. C., Sanjaya, L. A., Robby, D. K., Ahmad, N. J., Darman, D. R., Alizkan, U., ... & Kurniawan, B. R. (2021, October). Dissemination of GOOPI (Game Open Online Physics Instructional) to Sparking Innovation in Education. In *Journal of Physics: Conference Series* (Vol. 2019, No. 1, p. 012040). IOP Publishing.
[28] Dewi, P. Y., & Primayana, K. H. (2019). Effect of learning module with setting contextual teaching and learning to increase the understanding of concepts. *International Journal of Education and Learning*, *1*(1): 19-26.
[29] Tomasik, M. J., Helbling, L. A., & Moser, U. (2021). Educational gains of in-person vs. distance learning in primary and secondary schools: A natural experiment during the COVID-19 pandemic school closures in Switzerland. *International Journal of psychology*, *56*(4): 566-576.
[30] Lemmer, M. (2018). Applying the science of learning to the learning of science: Newton's second law of motion. *Africa Education Review*, *15*(1): 20-37.