EDUMATSAINS
JURNAL PENDIDIKAN MATEMATIKA DAN SAINS
E-ISSN:2527-7235
Volume 9 Issue. 1, July, 2024, pp 345-355
http://ejournal.uki.ac.id/index.php/edumatsains

The Application of The Condition Construction Development Simulation Reflection (CCDSR) Learning Model Assisted by A Combination of Real-Virtual Experiments on Students' Science Process Skills on Static Fluid Material

Aas Aisyah[1], Duden Saepuzaman[2*], Saeful Karim[3]
[1,2,3]Pendidikan Fisika FPMIPA Universitas Pendidikan Indonesia
e-mail: *dsaepuzaman@upi.edu

Article Info
Article history
Received : July 11, 2024
Revised : July 31, 2024
Accepted : July 31, 2024
Available online : July 31, 2024

https://doi.org/10.33541/edumatsains.v9i1.6064

Abstract
Students' science process skills continue to be in the low range. This results from a deficiency of educational activities that help pupils hone and expand upon the science process abilities they already possess. The purpose of this study is to ascertain how science process abilities can be improved by using the CCDSR learning model in conjunction with real-virtual experiments on static fluid material. This study employed a quantitative approach using a one group pretest-posttest research design, with 31 participants who are MIPA class XI students. With the use of IBM SPSS version 29 software, data was collected using scientific process skills test instruments and analyzed using N-Gain, homogeneity, normality, and hypothesis testing. The medium category's N-Gain test has a significance value of 0.62 based on data processing results. Thus, it can be said that students' science process abilities on static fluid material can be enhanced by using the CCDSR learning model in conjunction with a mix of real-virtual experiments. Based on the research that has been conducted, additional research is required to address a number of issues. These issues include the need to regularly check the availability and functionality of the simulation used, extend the time allocation used, and include a control class to compare the results.

Keywords: CCDSR Learning Model, Real-Virtual Experiment Combination, Science Process Skills, Static Fluid

1. Introduction

Critical thinking abilities are one of the fundamental abilities needed to meet the difficulties of the twenty-first century and deal with the technological advancements brought about by the industrial revolution. Science process skills and critical thinking abilities are closely related. Nugraha, Suyitno, and Susilaningsih (2017) claim that thinking abilities can be influenced by science process skills by as much as 41.5%. Reiterated by Hariandi, Sitompul, and Habellia (2023) is the idea that students can develop higher order thinking skills and other talents by practicing science process skills.

According to Amnie et al. (2014), science process skills are lessons created to help students locate information, develop concepts, and formulate theories. To put it another way, students are taught to be competent—that is, to search, discover, study, and solve problems in their environment in order to create laws or scientific theories (Rahmah et al., 2019).

This demonstrates the need of teaching students science process skills in order to enable them to develop sophisticated comprehension of the subject matter they are studying. According to Zurweni, Kurniawan, and Triani (2022), science process skills should be taught from the beginning of a student's education since they can improve their comprehension of the subject matter.
The data in the field indicates that pupils' proficiency with the scientific method is still lacking. According to Mahmudah, Makiyah, and Sulistyaningsih's (2019) analysis of high school students' science process skills, the majority of students' skills remained in the low category. This is a result of the learning process not being sufficient to properly train science process abilities. This finding aligns with the research undertaken by Barus, Bukit, and Jaya (2024), which indicates that students' process skills remain inadequate. Because during the learning process, students concentrate on the computation results rather than engaging in experimental activities to obtain understanding of the subject matter. This indicates that learning scientific process skills have not been fully trained. in order to affect the students' still-low science process skills.

In accordance with Yunita & Nurita (2021), facilitating opportunities for students to enhance and refine their science process abilities during the learning process is one way to help them become better. The Condition, Construction, Development, Simulation, Reflection (CCDSR) learning model is one of the models with features that can help students acquire science process abilities in learning activities (Limatahu, Wasis, et al., 2018).

Through scientific activities, the CCDSR learning model aims to enhance students' science process abilities (Limatahu, Wasis, et al., 2018). With the use of experimental activities, student-centered learning activities give students the chance to actively participate in the process of honing their science process abilities. This is consistent with the claim made by Limatahu, Suyatno, Wasis, and Prahani (2018) that the teacher's main responsibility while utilizing the CCDSR learning model is to serve as a facilitator and guide for the students.
The CCDSR learning model (condition, construction, development, simulation, and reflection) is a valuable tool for improving science process skills. However, it is important to note that each stage of the learning process—condition, construction, development, simulation, and reflection—must be considered simultaneously. Rahman & Limatahu (2020) state that phase 2, or building, is where the majority of the application of science process abilities in learning that are developed in the CCDSR learning model occurs. At this point, groups of students do experiments to hone their science process skills.

According to earlier studies on the CCDSR learning model, the model's application is still classified as fairly effective (Rahman & Limatahu, 2020; Saiful et al., 2021). Furthermore, the enhanced proficiency in scientific process abilities remains in the moderate range (Darman et al., 2021; Harnino, 2022). Studies conducted by Makian (2022) and Kapulangan (2022) also demonstrated that there were no appreciable changes in the enhancement of students' science process skills when the CCDSR learning model was used vs when it wasn't. These experiments suggest that training CCDSR learning just with the model is not ideal. Thus, additional elements are required to help pupils become better trained in science process abilities.

One alternative solution that can be used to further train students' science process skills is to add simulation-based experimental activities to the learning stages. This solution is used based on the syntax of the CCDSR model itself, where in stage 4, namely simulation, students will simulate their science process skills (Limatahu, Wasis, et al., 2018). That is, at the learning stage students will conduct real experiments at stage 3 (development) then students will conduct experiments again at stage 4 (simulation) by simulating material that cannot be done in real life by using a virtual laboratory.

The sequence of experiments used in this study is a real experiment first then continued with virtual experiments (real-virtual). This is based on the results of research conducted by Saepuzaman (2015) and Siswono et al. (2016) which stated that the improvement of students' science process skills by using real-virtual experiments was higher than that of virtual-real experiments. Placement of real experiments at the beginning of the activity is used so that students gain experience and understanding directly. While virtual experiments act as reinforcement and complement the shortcomings that exist in real experimental activities (Puji Hartini, 2017).

Furthermore, the material used in this study is static fluid material. The selection of this material is based on two factors, namely first, static fluid material is a physics topic that is considered difficult by students because of its abstract concepts, one of which is hydrostatic pressure material (Aboi et al., 2018; Kurniawan, 2023). For example, students still assume that the amount of hydrostatic pressure is influenced by the surface area of the object and the volume of the object (Prastiwi et al., 2018). This error occurs because students cannot directly see the pressure changes that occur in a fluid. Therefore, to explain pressure material, it is necessary to add media that can explain abstract material, namely simulation. Secondly, the learning process that solely relies on the lecture approach without incorporating the students' own discovery process may also contribute to the lack of understanding among students. This is consistent with the findings of a study by Simamora et al. (2023), which showed that a teacher's teaching style is one of the elements contributing to the formation of students' misconceptions in static fluid content. This indicates that the material is appropriate for use in this study since it includes static fluid content, which requires direct student participation during training and the use of simulation as a medium for explaining abstract material.

According to the above description, the researchers are looking to find out how students' science process abilities on static fluid material are affected when the CCDSR learning model is applied in conjunction with virtual reality trials. This study differs from others in that it uses a combination of virtual and real tests, together with static fluid as the material. Therefore, the purpose of this study is to ascertain how implementing the CCDSR learning model, in conjunction with a mix of real-virtual experiments on static fluid material, might increase science process abilities.

2. Methods

The research method used in this research is an experimental method with a one group pretest posttest research design with the research design to be carried out being presented in table 1.

Table 1. Types of Research One Group Pretest Posttest Design

Pretest	Treatment	Posttest
O_1	X	O_2

Source: Sugiyono (2013)

This study took place over the course of two weeks at one of Subang Regency's State Senior High Schools. Thirty one grade 11 MIPA students participated in the activity. A multiple-choice test instrument with eighteen items that represent aspects of science process skills measured—such as observing, formulating problems, formulating hypotheses, identifying variables, formulating operational definitions of variables, designing and carrying out experiments, analyzing data, communicating, and drawing conclusions—was used to gather data on students' science process skills. Data was collected through learning activities, beginning with the administration of questions (pretest) to students to assess their science process abilities before to treatment. Next, continue treating patients by utilizing the CCDSR learning model with support from a mix of virtual and real-world studies. In order to assess students' science process skills following treatment, a posttest was administered to them in the final activity.

The data analysis technique used descriptive statistics and inferential statistics. In the inferential statistical analysis, prerequisite tests were carried out first, namely normality and homogeneity tests. After that, hypothesis testing was carried out to find out significant differences between pretest and posttest results using the Mann Whitney test. The measurement of the improvement of science process skills can be done using the N-Gain test with the following criteria.

Table 2. Interpretation of N-Gain Values

$\langle g \rangle$	Interpretation
$\langle g \rangle \geq 0{,}70$	High
$0{,}70 > \langle g \rangle \geq 0{,}30$	Medium
$\langle g \rangle < 0{,}30$	Low

Source: (Hake, 1998)

3. Result and Discussion

The findings of the student scientific process skills exam show the effects of using the CCDSR (condition, construction, development, simulation, reflection) learning model in conjunction with a combination of real-virtual experiments on science process skills on static fluid material. Eighteen multiple-choice questions are used to gauge the progress made in science process abilities. Table 3 displays the instrument matrix for tests of scientific process skills on static fluid material.

Table 3. Instrument Matrix for Testing Science Process Skills on Static Fluid Material

Material	Question Number	Indicators of Science Process Skills								
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Hydrostatic Pressure	2	√								
	6			√						
	8				√					
	11						√			
	12								√	
	13									√
	18							√		
Pascal's Law	7				√					
	14								√	
Archimedes' Law	1	√								
	3		√							
	5			√						
	9					√				
	10					√				
	17							√		
Viscosity	4		√							
	15									√
	16							√		

The information on each aspect of students' science process skills is as follows.
1 : Observe
2 : Formulate the problem
3 : Contructing hypotheses
4 : Identifying variables
5 : Defining variables operationally
6 : Design and conduct an experiment
7 : Interpretation data
8 : Communicating
9 : Inference

This measurement was carried out before and after the application of the CCDSR learning model assisted by a combination of real-virtual experiments in the learning process. The results of descriptive analysis, students' science process skills from pretest and posttest results can be seen in Table 4.

Table 4. Results of Descriptive Analysis of Students' Science Process Skills

Test	N	$\overline{X}$	Standard Deviation	Variance	Highest Value	Lowest Value
Pretest	31	31.39	10.741	115.359	61	6
Posttest	31	71.84	11.337	128.533	94	50

The data presented in Table 4 indicates that there has been an increase in the average value of students' science process skills during the posttest. The average score for students' science process skills on the pretest was 31.39, and the average score on the posttest was 71.84. Aside from that, prior to the learning model's installation, the science process skills had lowest and greatest values of 6 and 61. In the meantime, following the adoption of the learning model, students' science process skills scores ranged from 50 to 94. These findings indicate that there is a large variation in scores. To determine whether or not the sample data can accurately represent the population, inferential tests must be performed because the differences in values do not allow the results to be generalized (Sugiyono, 2013). First, the normality and homogeneity tests must be performed in order to decide which inferential statistical tests are parametric or non-parametric.

To ascertain whether or not data is regularly distributed, one might apply the normality test. In the meantime, information regarding the homogeneity of data is obtained using the homogeneity test. The findings of the analysis were used to determine the outcomes of the homogeneity and normalcy tests. Table 5 displays the data from the pretest-posttest.

Table 5. Normality Test Results

	Shapiro-Wilk		
	Statistik	**df**	**Sig.**
Pretest	0.905	31	0.010
Posttest	0.941	31	0.086

Table 6. Homogeneity Test Result

	Sig.
Pretest-posttest	0.555

According to Table 5, the pretest significance value is 0.010, whereas the post-test significance value is 0.086. Given that the significant value of the pretest results is less than 0.05 (0.010 < 0.05), this suggests that the pretest data is not regularly distributed. Meanwhile, a significant value of 0.555 was found for the homogeneity test that is displayed in Table 6. This indicates that the value of data homogeneity (0.555 > 0.05) is greater than 0.05. Thus, it is asserted that the research data group is homogeneous or comparable.

The results of the preceding test indicate that the data is not normally distributed since the normality test that was performed yielded a value less than the minimum significance of 0.05. Consequently, the Mann-Whitney test is the hypothesis test that is employed. Table 7 displays the findings of this study's hypothesis test analysis.

Table 7. Mann-Whitney Test Results

	Posttest – Pretest
Z	-6.740
Asymp. Sig. (2-tailed)	<,001

Based on Table 7, the value of Asymp. Sig. (2-tailed) value is <0.001, which means that the Sig. (2-tailed) data <0.05, then in this study H_0 is rejected and H_a is accepted. It can be concluded that there is a difference in the average value of students' science process skills before and after the application of the CCDSR learning model assisted by real-virtual experiments on static fluid measurement.

Additionally, N-Gain analysis was used to determine the extent of the improvement in students' science process abilities following the implementation of the CCDSR learning model with the use of real-virtual experiments in static fluid learning. Table 8 displays the N-Gain values derived from the pretest and posttest data in this investigation.

Table 8. N-Gain values for all SPS aspects

Average Score			**Category**
Pretest	**Posttest**	**N-Gain**	
36	82	0.62	Medium

Table 8 displays the attainment of an N-Gain value of 0.62 in the intermediate category. Thus, it demonstrates that the use of the CCDSR learning model, aided by a combination of virtual and actual experiments, results in an enhancement in students' science process skills. This is consistent with studies by Darman et al. (2021) showing that science process abilities of students can be enhanced through learning with the CCDSR learning paradigm. Additionally, one strategy for enhancing students' science process skills is the utilization of real-virtual combinations. Puji Hartini's (2017) research supports this, showing that the use of a learning model aided by a combination of actual and virtual experiments might increase students' science process skills with a high category. According to studies by Siswono et al. (2016), Puji Hartini (2017), and Saepuzaman et al. (2015), students' science process skills and concept mastery were enhanced by the learning model with the use of a combination of real and virtual experiments. This leads to the conclusion that all aspects of students' science process abilities can be improved through the use of the CCDSR learning model in conjunction with a mix of actual and virtual activities.

Furthermore, the findings of student answers during the pretest and posttest demonstrate an improvement in science process skills for each aspect. In order for Figure 1 to display the findings of the analysis of improvement for every facet of science process skills.

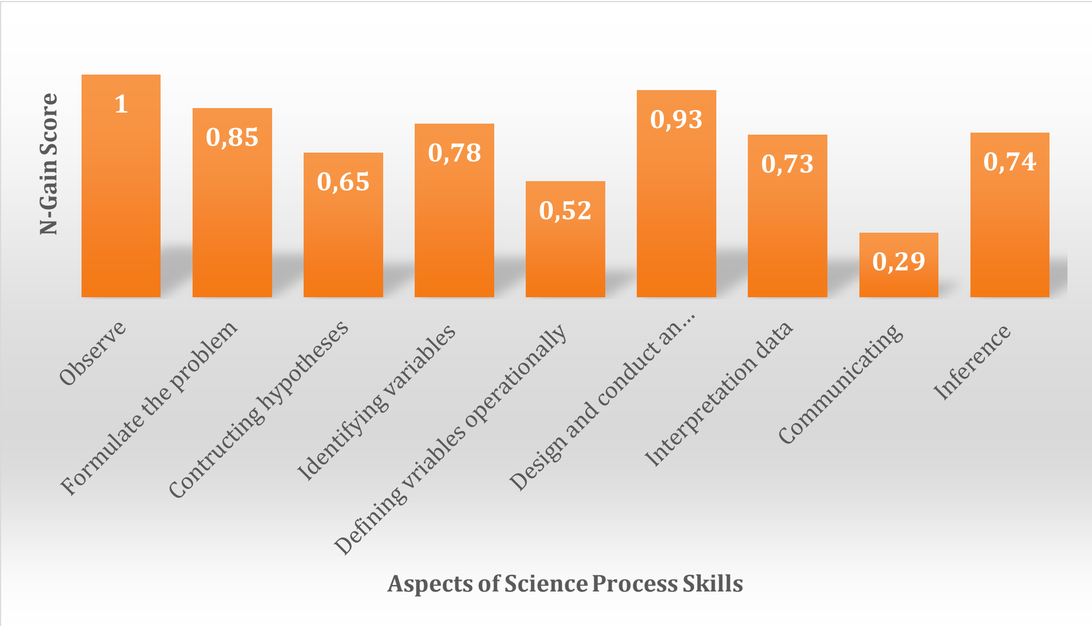

Figure 1. Comparison Chart of N-Gain on Each Aspect of Science Process Skills

The average N-Gain value for each component of science process skills (SPS) has increased, as can be seen in the above figure 1. According to Ricard R. Hake (1998), the categories of "High" now include observation, problem formulation, variable identification, experiment design and execution, data analysis, and conclusion. In the meantime, the "Medium" category now includes the definition of operational variables and the formulation of hypotheses. Additionally, a rise in the "Low" category is communicated. Furthermore, as can be seen from Figure 1's study results, the observing element of the KPS saw the most improvement, while the communicating aspect saw the least increase. This is because difficulties involving observation are simple for students to resolve because observing is the most fundamental KPS feature in science (Yunita & Nurita, 2021). Furthermore, during the learning process, images or videos pertaining to the sub-chapter under discussion are presented to train the observing element. As a result, students can participate fully in the process of observing. This affects the KPS exam results, which demonstrate that every student can accurately respond to the observation questions.

Moreover, the communicative aspect was the KPS aspect with the lowest N-Gain value. During the learning process, participants practiced communicating by giving presentations that outlined the experimental findings they had from their practicum activities. Additionally, students were instructed to switch from tables to graphs as the data display format during the experiment. Students are required to transform the data from the table into a graph showing the link between two variables for the science process skills test questions. The outcomes of raising this factor remain in the low range in both cases. This is because students are not used to interpreting research findings because these experimental activities are being conducted for the first time. in order to prevent pupils from becoming accustomed to presenting material or even changing its format. This is consistent with study findings by Yunita & Nurita (2021), which show that students were not generally prepared to explain concepts using graphs or tables as part of their learning process.

The average total SPS increase in the medium category was 0.62, based on the N-Gain calculation results for each area of scientific process skills in static fluid material. An increase in the moderate category indicates that some pupils are still not able to provide accurate answers to queries. This suggests that pupils still have ways to go in mastering the science process abilities.

Furthermore, the repetition of experimental tasks helps students strengthen their scientific process skills. Students' science process abilities get further taught as they repeat twice-conducted experiments, in a virtual and actual setting. To become more adept at applying the science process in learning activities, students complete all of the KPS indicators that are repeatedly trained. The learning results of the students are then impacted by this repetition of the material. Students' comprehension of the subject they have learned can be strengthened by repeating experimental exercises. This is due to the fact that students are given information twice: initially, they learn fundamental ideas through actual experiments, and then they are reinforced by virtual experiences (Saepuzaman et al., 2015).

On the other hand, the role of the teacher is also a support in developing their science process skills during the learning process. According to Yunita & Nurita (2021), student-focused learning tends to provide high science process skills. Then, Barus et al. (2024) also said that students' understanding also increases because students directly carry out learning activities. Therefore, the increase in science process skills is in line with the increase in students' understanding of material as a result of learning.

4. Conclusion

Based on the previous research findings, the implementation of the CCDSR learning model, aided by a mix of real-virtual experiments, was able to increase science process abilities with an N-Gain value of 0.62 in the medium category. Furthermore, the portion of science process abilities that saw the greatest development was the observational component, with an N-Gain value of 1, and the communication component, with a value of 0.29, saw the least gain. Nevertheless, following the implementation of the CCDSR learning model and with the support of a mix of real and virtual learning experiments, every facet of KPS—such as observation, problem formulation, variable identification, experiment design and execution, data analysis, and conclusion—rose with high categories. On the other hand, developing hypotheses and identifying operational variables fall inside the medium group. Additionally, speaking falls under the low category.

5. References

Aboi, Tandililing, E., & Mursyid, S. (2018). Remediasi Pemahaman Konsep Tekanan Hidrostatik Menggunakan Model Ecirr Di Sma Negeri 1 Sungai Ambawang. *Angewandte Chemie International Edition, 6(11), 951–952.*, 10–27.

Amnie, E., Abdurrahman, & Ertikanto, C. (2014). Pengaruh Keterampilan Proses Sains terhadap Penguasaan Konsep Siswa pada Ranah Kognitif. *Jurnal Pendidikan Fisika*, *2*(7), 123–137.

Barus, C. S. A., Bukit, N., & Jaya, G. W. (2024). Meningkatkan Keterampilan Proses Sains Siswa Pada Pembelajaran Fisika Materi Fluida Statis. *Edukatif: Jurnal Ilmu Pendidikan*, *6*(2), 1545–1553.

Darman, L., Limatahu, I., & Achmad, R. (2021). *Penerapan Model Pembelajaran CCDSR (Condition, Construction,Divilopment, Simulation, Refflection) untuk MeningkatkanKeterampilan Proses Sains Mahasiswa pada Konsep Likuifaksi*. *6*(1), 2087–3816.

Hake, R. R. (1999). Analyzing change/gain scores. *AREA-D American Education.*, *16*(7), 1073–1080.

Hariandi, J., Sitompul, S. S., & Habellia, S. R. (2023). *Peningkatan Keterampilan Proses Sains dengan Menerapkan Pendekatan STEAM*. *11*(2), 2442–4838. https://doi.org/10.24127/jpf.v11i2.7945

Harnino, E. (2022). *Impelementasi Model Pembelajaran CCDRS (Condition, Construction, Divilopment, Simulation, Refflection) untuk MeningkatkanKeterampilan Proses Sains siswa Madrasah Aliyah Negeri 2 Tidore Kepulauan pada materi usaha dan energi* [Universitas Khairun]. http://digilib.unkhair.ac.id/895/2/3. Abstrak bahasa Indonesia dan bahasa Inggris.pdf

Kapulangan, A. M. (2022). *Penerapan Model Pembelajaran CCDSR untuk Meningkatkan Keterampilan Proses Sains Siswa Kelas X SMA Kristen Dian Halmahera* [Universitas Khairun]. http://digilib.unkhair.ac.id/1901/4/Abstrak Bahasa Indonesia Abstrak Bahasa Inggris.pdf

Kurniawan, R. V. (2023). Analisis Pemahaman Konsep Siswa Pada Topik Fluida Statis. *TEACHING : Jurnal Inovasi Keguruan Dan Ilmu Pendidikan*, *3*(1), 67–73. https://doi.org/10.51878/teaching.v3i1.2165

Limatahu, I., Suyatno, Wasis, & Prahani, B. K. (2018). The effectiveness of CCDSR learning model to improve skills of creating lesson plan and worksheet science process skill (SPS) for pre-service physics teacher. *Journal of Physics: Conference Series*, *997*, 012032. https://doi.org/10.1088/1742-6596/997/1/012032

Limatahu, I., Wasis, Sutoyo, S., & Prahani, B. K. (2018). Development Of CCDSR Teaching Model to Improve Science Process Skills of Pre-Service Physics Teachers. *Journal of Baltic Science Education*, *17*(5), 812–827. https://doi.org/10.33225/jbse/18.17.812

Makian, R. (2022). *Implementasi Model Pembelajaran CCDSR (Condition, Construction, Development, Simulation, Reflection) Berorientasi Keterampilan Proses Sains Untuk Meningkatkan Hasil Belajar Fisika Siswa Kelas XI SMA Negeri 1 Kota Ternate* [Universitas Khairun]. http://digilib.unkhair.ac.id/3163/

Nugraha, A. J., Suyitno, H., & Susilaningsih, E. (2017). Analisis kemampuan berpikir kritis ditinjau dari keterampilan proses sains dan motivasi belajar melalui model PBL. *Journal of Primary Education*, *6*(1), 35–43.

Prastiwi, V. D., Parno, P., & Wisodo, H. (2018). Identifikasi pemahaman konsep dan penalaran ilmiah siswa SMA pada materi fluida statis. *Momentum: Physics Education Journal*, *2*(2), 56–63. https://doi.org/10.21067/mpej.v1i1.2216

Puji Hartini, R. I. (2017). Penggunaan Levels of Inquiry Dalam Meningkatkan Keterampilan. *Jurnal Ilmu Pendidikan Fisika*, *2*(1), 19–24.

Rahman, R. A., & Limatahu, I. (2020). Melatihkan Keterampilan Proses Sains Siswa SMA Negeri 8 Kota Ternarte Melalui Penerapan Model Pembelajaran CCDSR (Condition, Construction, Development, Simulation, Reflection). *JPPS (Jurnal Penelitian Pendidikan Sains)*, *9*(2), 1783–1789. https://doi.org/10.26740/jpps.v9n2.p1783-1789

Saepuzaman, D., Kaniawati, I., Utari, S., & Karim, S. (2015). *Penerapan Kombinasi Eksperimen Nyata-Virtual Pada Materi Rangkaian Listrik Arus Searah Untuk Meningkatkan Keterampilan Proses Sains Siswa SMA*. 108–115.

Saiful, S., Limatahu, I., & Achmad, R. (2021). Efektivitas Model Pembelajaran CCDSR (Condition, Contruction, Development, Simulation, Reflection) untuk Meningkatkan Keterampilan Proses Sains Siswa Kelas XI-IPA SMA Negeri 13 Halmahera Selatan Pada Konsep Hukum Newton Tentang Gerak. *SAINTIFIK@: Jurnal Pendidikan MIPA*, *6*(2). https://doi.org/10.33387/saintifik.v6i2.3889

Simamora, R., Maison, & Kurniawan, W. (2023). Identifikasi Miskonsepsi Siswa Menggunakan Five-Tier Diagnostic Test pada Materi Fluida Statis di SMAN 7 Kota Jambi. *Jurnal Penelitian Pendidikan Fisika*, *8*(2), 139–144. https://doi.org/10.36709/jipfi.v8i2.18

Siswono, H., Wartono, & Koes, S. (2016). Pengaruh problem based learning berbantuan kombinasi real dan virtual laboratory terhadap keterampilan proses sains dan penguasaan konsep siswa di SMAN 1 Lumajang. *Jurnal Riset Pendidikan Fisika*, *1*(1), 5–16. http://journal2.um.ac.id

Sugiyono. (2013). *Metode Penelitian Kuantitatif Kualitatif dan R&D*. Alfabeta.

Yunita, N., & Nurita, T. (2021). Analisis Keterampilan Proses Sains Siswa Pada Pembelajaran Daring. *Pensa E-Jurnal : Pendidikan Sains* , *9*(3), 378–385. https://ejournal.unesa.ac.id/index.php/pensa