Student's Written Communication Skills in Learning Physics Using Virtual Lab-Based Video Tutorials

Sutarno Sutarno[1](✉), Desy Hanisa Putri[2], Adam Malik[3], Gunawan Gunawan[4], and Andik Purwanto[2]

[1] Program Studi Pendidikan IPA, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Bengkulu, Jl. W.R. Supratman, Bengkulu, Kandang Limun 38122, Indonesia
m.sutarno@unib.ac.id

[2] Program Studi Pendidikan Fisika, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Bengkulu, Jl. W.R. Supratman, Bengkulu, Kandang Limun 38122, Indonesia

[3] Program Studi Pendidikan Fisika, UIN Sunan Gunung Djati Bandung, Jl. A.H. Nasution No. 105, Cibiru Bandung 40614, Indonesia

[4] Program Studi Pendidikan Fisika, Universitas Mataram, Jl. Majapahit No 62, Mataram 83125, Indonesia

Abstract. This action research aims to improve students' written communication skills in the aspect of information and data representation skills (IDRS) in Basic Physics Courses through learning using virtual lab-based video tutorials. The research subjects consisted of 26 students of the Science Education Study Program who took the 2020/2021 Basic Physics Course. The research instrument was in the form of a test sheet for IDRS. The impact of treatment is described through the average test score and the level of effectiveness of using virtual lab-based video tutorials. Based on the pretest and posttest scores, it is known that the students' average N-gain IDRS is in the medium category in the cycle 1, and the high category in the cycles 2 and 3. The number of students who achieved the high category in the cycle 3 has reached more than 75%. Based on the results of the study, it can be concluded that learning physics using video tutorials based on virtual labs has a high effectiveness in increasing students' IDRS.

Keywords: Written Communication · Learning Physics · Virtual Lab · Video Tutorials

1 Introduction

Today's learning should be directed to encourage students to master transferable skills [1]; use of ICT technology in concept finding activities; mastery of technological literacy, digital literacy and human literacy. Technological literacy in the form of the ability to operate and utilize technology wisely, digital literacy in the form of the ability to read, analyze, use and develop digital information appropriately; and human literacy in the form of the ability to communicate and collaborate in a globalized world [2].

© The Author(s) 2023
M. L. Firdaus and A. Defianti (Eds.): MASEIS 2021, ASSEHR 718, pp. 307–315, 2023.
https://doi.org/10.2991/978-2-38476-012-1_38

Physics learning is an important part of science education which has the potential to train written communication skills [3]. This potential is important to explore considering that the purpose of learning physics emphasizes the mastery of written communication skills in every procedure of the science dimension [4]. The dimensions of science include (1) the dimensions of knowledge and understanding, and (2) the dimensions of excavation and discovery [5]. For example in the dimensions of excavation and discovery, when students conduct investigations to reveal the relationship between measurement variables, students are required to be able to organize the data obtained in the form of tables, charts, curves, graphs, pictures or other forms of representation [6, 7]. Organizing the data aims to make it easier to interpret the relationship between variables quickly and precisely. Based on this example, it appears that learning physics has great potential in providing written communication skills [8].

One of the potential physics learning activities in providing written communication skills is excavation and discovery activities through laboratory activities [7]. Measurement and observation activities are important representations of the dimensions of science that cannot be separated from learning physics. Some of the benefits of measurement and observation activities according to several research results are that they can build understanding of concepts and science process skills [9], develop basic skills of experimenting [10]; as a way to confront students' preconceptions [11, 12], and train students to find relationships between physical variables [13]. These benefits can be achieved if students have good abilities in representing various information and data obtained from the measurement and observation activities they have done.

Although measurement and observation activities can provide various benefits in learning physics, in reality they still have many limitations, such as the infrequent implementation of laboratory activities [14]; a long time span between concept delivery and concept verification through laboratory activities, causing students' understanding of concepts to be incomplete; laboratory activities have not been integrated into the learning process in the classroom to find and build concepts [13]; and the purpose of lab activities is generally still directed at mastering certain material concepts, not yet directed to equip important skills such as collaboration skills and scientific communication skills [15].

Several recommendations can be chosen to increase the benefits of measurement and observation activities, namely: (1) the limitations of lab equipment can be overcome by using a virtual lab (virtual practicum) [16], (2) measurement and observation activities must be integrated into the learning process in class to build (construct) physics concepts, not just to verify the correctness of the concepts that have been conveyed previously, (3) Lab activity guides are equipped with demonstration videos of measurement procedures, data analysis, and other additional explanations so that measurement and observation activities can run effectively [6], (4) The purpose of lab activities should also be directed to equip other important skills such as collaboration skills and written communication skills and the manual used must contain indicators of the skills to be provided [15].

Projectile motion, simple pendulum, and dynamic electricity are potential basic physics materials to practice written communication skills. Mastery of this concept will be the basis for mastering other physics concepts. Basic physics courses require students to be able to build, understand and verify basic physics concepts through various excavation and discovery activities (measurements and observations), both macroscopic concepts and microscopic or abstract concepts. The skill of representing information and data in various forms of representation is a basic soft skill of written communication skills that must be possessed so that students are able to construct and reconstruct their knowledge in every excavation and discovery activity [17–19]. In addition, in this course students are required to be able to use a variety of learning media and ICT-based technology that can make it easier for them to build and understand physics concepts, especially abstract or microscopic concepts. One of the learning objectives that must be achieved by students in the material of projectile motion, simple pendulum, and dynamic electricity through scientific investigations is that students are able to correctly determine the relationship between several physical variables contained in Eqs. (1), (2) and (3).

$$x = v_0^2\left(\frac{sinsin2\theta}{g}\right) \tag{1}$$

$$T = 2\pi\sqrt{\frac{L}{g}} \tag{2}$$

$$V = V_1 + V_2 + V_3 = IR_1 + IR_2 + IR_3 \tag{3}$$

Equation (1) shows the relationship between the variables of the farthest reach of the projectile on the horizontal axis (x) with the initial velocity (v_0), angle of elevation (θ) and the constant of gravity (g) where the experiment was carried out. Equation (2) shows the relationship between the variable period of the pendulum swing (T) with the length of the pendulum string (L) and the constant of gravity (g) where the experiment was carried out. At a small swing angle and without air resistance, the pendulum swing period is obtained that is not affected by the pendulum mass. Equation (3) shows the relationship between the variable voltage (V) with electric current (I) and electrical resistance (R) in a series circuit.

There is a physics learning strategy that can summarize the various recommendations that have been stated previously, namely through learning using virtual lab-based video tutorials. Physics tutorial videos show observation and measurement procedures that are equipped with explanations in the form of audio narration (voice), dynamic text and images. The media used in the measurement and observation activities are interactive computer simulations to visualize abstract phenomena that are impossible to observe in a real laboratory [20]. At the end of the video tutorial presentation, students are asked to take measurements and re-observe with different data using a virtual lab-based student worksheet.

2 Method

This action research was conducted in three learning cycles. The physics concepts studied were projectile motion (cycle 1), simple pendulum (cycle 2), and dynamic electricity (cycle 3). In the implementation of learning, students actively listen to the material and measurement activities described and demonstrated in the video tutorial, then they are asked to take measurements and re-observe using different data. Student activities are guided by student worksheets.

Table 1. IDRS Pretest and Posttest Scores

	Cycle 1		Cycle 2		Cycle 3	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Mean	31.79	61.35	31.03	82.44	31.79	84.62
Average N-Gain	0.61		0.75		0.78	
CLC (%)	0	69.23	0	84.62	0	88.46
CA (%)	32.76	74.10	31.03	82.44	31.79	84.62

This research involved 26 students (4 boys and 22 girls, age range 19–20 years) in the Science Education Study Program at Universitas Bengkulu Indonesia who took basic physics courses in the odd semester of the 2020/2021 Academic Year. The main data were collected through the pretest and posttest of information and data representation skills (IDRS) in each learning cycle. Pretest and posttest are given before and after students take part in learning, containing essay questions that represent IDRS indicators. The test result data is used to determine the level of effectiveness of using virtual lab-based video tutorials in improving students' IDRS.

The level of effectiveness of implementing virtual lab-based video tutorials in improving students' IDRS is determined by calculating the percentage of students who have reached the high N-gain category in each learning cycle. The effectiveness of learning is called high if the number of students who reach the high N-gain category reaches 75%, it is called to be moderate if the number of students who reach the high N-gain category is in the range of 50%. - 75%, and is called to be low if the number of students who reach the high N-gain category is less than 50% [21].

3 Result and Discussion

3.1 Result

Before and after participating in basic physics learning activities using virtual lab-based video tutorials, students are given a pretest and posttest to determine the achievement of increasing the IDRS score (N-gain). The mean scores of pretest, posttest, and Classical Learning Completeness (CLC), and Classical Absorption (CA) concepts of projectile motion (cycle 1), simple pendulum (cycle 2), and dynamic electricity (cycle 3) obtained by students are shown in Table 1.

There are three IDRS indicators that are trained through learning using video tutorials based on virtual labs, namely the skills to represent measurement data in the form of graphs and tables (IDRS-1), skills to represent measurement data in verbal form (IDRS-2), and skills to represent graphs and tables into verbal form (IDRS-3) [3]. Student scores on each IDRS indicator are shown in Table 2.

The effectiveness of the implementation of learning using video tutorials based on virtual labs in increasing student IDRS is determined by calculating the percentage of students who have reached the high N-gain category. The data on the percentage of students with the N-gain IDRS category in all learning cycles is shown in Table 3.

Table 2. Score of Written Communication Skills (WCS) per Indicator of Each Learning Cycle

WCS Score		Cycle-1	Cycle-2	Cycle-3	Average
WCS-1	Pretest	26.92	25.00	25.00	31.19
	Posttest	64.62	73.85	75.00	61.35
	N-gain	0.51	0.64	0.66	0.61
WCS-2	Pretest	25.00	39.23	28.85	31.03
	Posttest	73.85	90.00	83.46	82.44
	N-gain	0.64	0.84	0.78	0.75
WCS-3	Pretest	25.00	40.38	30.00	31.79
	Posttest	75.00	93.85	85.00	84.62
	N-gain	0.66	0.89	0.79	0.75

Table 3. Number of Students in Each N-gain IDRS Category

Learning Cycles	High (%)	Medium (%)	Low (%)
Cycle 1	53,85	38,46	7,69
Cycle 2	80,77	15,38	3,85
Cycle 3	84,62	15,38	0

3.2 Discussions

Video tutorials based on virtual labs used in learning basic physics contain audio narration, text, and images that are supported by the presence of interactive physics simulations. Physics simulation is used to demonstrate the relationship between variables through measurement activities that will lead students to understanding the concepts or theories being studied. Data from measurements and observations on demonstration activities are used to build important concepts. For example, a demonstration related to a projectile fired from a cannon with varying angles of elevation. In this activity, data obtained from the relationship between the angle of elevation (θ) and the maximum horizontal range (x) that the projectile can reach. The data is then organized into a table of experimental results showing the relationship between variables, control variables, independent variables, and dependent variables (measurement results variables). Based on the table it can be seen that at a certain elevation angle will produce the maximum horizontal range distance. Furthermore, students are invited to study the concept of projectile motion until a physical equation is obtained that represents the relationship between the variables of the elevation angle and the range of the projectile. Students are also invited to verify the data from the demonstration carried out with the physical equations that have been obtained.

At the end of the lesson, after watching the video tutorial, students were asked to take measurements and re-observe using different initial data. Student activities are guided

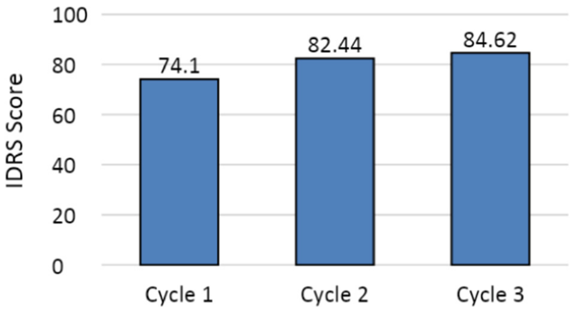

Fig. 1. IDRS Average Score

by student worksheets based on virtual labs that have been prepared. The worksheets has been designed to train and provide skills indicators to represent information and data from measurements and observations. Learning strategies that have been applied have been proven to improve skills in representing information and data. The virtual lab in the video tutorial acts as a medium to visualize abstract concepts so that they become more real so that they can be understood by students. The posttest data showed an increase in the score from 74.10 in the initial cycle to 84.62 in the final cycle. The comparison of the average IDRS scores in each cycle is shown in Fig. 1.

The increase in the average IDRS score as shown in Fig. 1 is also followed by an increase in classical learning completeness in each cycle, which is 69.23% on the concept of projectile motion, 84.62% on the concept of Newton's Law, and 88.46% on the concept of a simple pendulum. Although the absorption of students has not reached 100%, the absorption in the final cycle has reached the high category.

Based on IDRS score data before and after the implementation of virtual lab-based video tutorials, it is known that there is a significant increase in the pretest mean score, from the range of 31 – 33 to 74 – 85 in the posttest. The data in Table 2 shows that the average N-gain cycle 1 is in the range of 0.30 – 0.70 in the medium category, the N-gain cycle 2 is in the range 0.70–1.00 with the high category, and the N-gain cycle 3 is in the range of 0.70–1.00 with the high category. The average N-gain score has increased in each cycle. The increase in the average N-gain was followed by an increase in the number of students who achieved the high N-gain category in each cycle. The percentage of students who are in the High N-gain category is shown in Fig. 2.

The percentage of students who reach the high N-gain category is used to determine the level of learning effectiveness in improving students' IDRS. Based on Graph 2, it can be seen that the effectiveness of learning is in the Medium category, in cycle II (simple pendulum concept) it is in the high category, and in cycle III (dynamic electricity concept) it is in the high category in increasing the achievement of the three IDRS indicators. The effectiveness of the implementation of virtual lab-based video tutorials that have not been maximized in cycle 1 is because students are not used to taking lessons using virtual lab-based tutorial videos.

Learning physics using video tutorials based on virtual labs can enable students to understand measurement and observation procedures in order to build and discover concepts. Students then carry out these work procedures using new quantities to improve

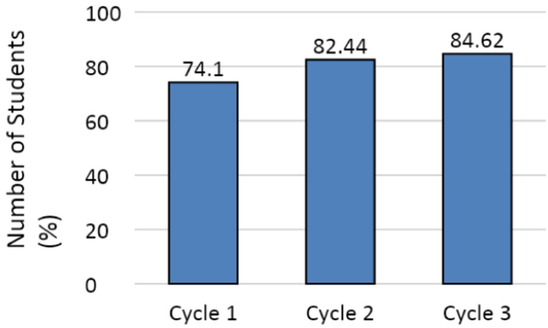

Fig. 2. Number of Students with High N-gain Category

understanding of concepts through direct activities. Furthermore, students are involved in the activity of representing the data from measurements and observations in various forms of appropriate representation to facilitate the data analysis process so that it can produce the right conclusions.

Another advantage of learning physics with the aid of video tutorials based on virtual labs is the presence of virtual lab software that can display abstract and microscopic phenomena that are impossible to observe through real equipment in the laboratory [20]. Computer simulations allow students to manipulate various variables quickly and safely so that they can explore and find patterns of relationships between variables [22]. In addition, the use of virtual labs in learning can provide time and cost efficiency; have the ability to visualize abstract and microscopic concepts; improve understanding of concepts, equip thinking and reasoning skills, can be learned anywhere and anytime that is not bound by place and time, avoids the risk of work accidents, supports independent learning, provides effective learning experiences; and provide feedback quickly on the given stimulus [11]. Especially during the Covid-19 pandemic, as it is today, physics learning assisted by video tutorial media based on virtual labs is very possible to be done online (distance learning) by utilizing existing social media such as YouTube, website, WhatsApp, Microsoft Teams, zoom, and others.

4 Conclusion

Based on the data and discussion, it can be concluded that the use of virtual lab-based video tutorials in basic physics learning has a high effectiveness in improving students' written communication skills in the aspect of information and data representation skills (IDRS). Based on students' IDRS scores, the IDRS indicators from the easiest to the most difficult for students to master are the skills to represent measurement data in the form of graphs and tables, the skills to represent measurement data in verbal form, and the skills to represent graphs and tables in verbal form.

Acknowledgments. This research was funded by the PPKP FKIP Research scheme at Universitas Bengkulu, Indonesia in 2020. The authors would like to thank the facilities provided during the research process.

References

1. Trilling, B., Fadel, C.: 21st century skills: learning for life in our times. John Wiley & Sons, USA (2009).
2. Aoun, J.E.: Robot-proof: higher education in the age of artificial intelligence. MIT Press, US (2017).
3. Spektor-Levy, O., Eylon, B., Scherz, Z.: Teaching communication skills in science: Tracing teacher change. Teaching and Teacher Education, 24 pp. 462-477 (2008).
4. Yuliati, D., Handayani, E.: Enhancement of communication skills through physics
5. learning with science, technology, engineering, and mathematics (STEM) approach. Journal of Physics: Conference Series, 918052083 (2020).
6. Putri, D.H., Risdianto, E., Sutarno, S.: Pre-service physics teachers' perception toward hands-on lab activity and their 21st century skills. Journal of Physics: Conference Series, 889 012015 (2017).
7. Sinaga, P., Suhandi, A., Liliasari: The effectiveness of scaffolding design in training writing skills physics teaching materials. International Journal of Instruction, 8(1) pp. 19-32 (2015).
8. Kusumawati, T.R.D., Supeno., Lesmono, A.D.: Student worksheet based on inquiry with vee map to improve writing skills in physics learning. Journal of Physics: Conference Series, 1465 012034 (2020).
9. Odja, A.H., Mursalin: The effectiveness of implementation cooperative learning model oriented life skills for the 21st century to improve writing science skills in physics concepts. Journal of Physics: Conference Series, 1171 012020 (2019).
10. Darmaji, D., Kurniawan, D.A., Irdianti, I.: Physics education students' science process skills International. Journal of Evaluation and Research in Education (IJERE), 8(2) pp. 293-298 (2019).
11. Hofstein, A., Lunneta, V.N.: The labority in science education: foundations for the twenty first century. Science Education, 88 pp. 28-54 (2004).
12. Srisawasdi, N., Kroothkeaw, S.: Supporting students' conceptual development of light refraction by simulation-based open inquiry with dual-situated learning model. J. Comput. Educ, 1 pp. 49-79 (2014).
13. Unal, S.: Changing students' misconceptions of floating and sinking using hand-on activities. Journal of Baltic Science Education, 7(3) pp. 134-146 (2008).
14. Sutarno, S., Putri, D.H., Risdianto, E., Satriawan, M., Malik, A.,: The students' physics problem solving skills in basicphysics sourse. Journal of Physics: Conference Series, 1731 012078 (2021).
15. Putri D.H, Risdianto, E., Sutarno: Identifikasi keterlaksanaan praktikum fisika SMA dan pembekalan keterampilan abad 21. In: Prosiding Seminar Nasional Sains dan Entrepreneurship IV. UPGRIS Press, Universitas PGRI Semarang, pp. 114–123 (2017).
16. Malik, A., Setiawan, A., Permanasari, A., Samsudin, A., Safiri, D., Lisdiani, A.S., Sapriadil., Hermita, N.: Using hot lab to increase pre-service physics teacher's critical thinking skills related to the topic of RLC circuit. Journal of Physics: Conf. Series, 1013 012023 (2018).
17. Maiyena, S., Haris, V.: Practically of video tutorials in physics experiments to improve students' science process skills. Jurnal Ilmiah Pendidikan Fisika Al-Biruni, 6(1) pp. 75-83 (2017).
18. Chick. H., Watson, J.: Data representation and interpretation by primary school students working in groups. Mathematics Education Research Journal, 13 pp. 91–111 (2001).
19. Shireman, M.: Developing science writing skills. Mark Twain Media Inc (2009).

20. Balgalmis, E., Temiz, Z.: Preparing data representation activities for young learners. Journal of Inquiry Based Activities, 8(1) pp. 1-10 (2018).
21. Chao, J., Chiu, J.L., DeJaeghe, C.J., Pan, E.A.: Sensor-augmented virtual labs: using physical interactions with science simulations to promote understanding of gas behavior. J Sci Educ Technol (2015).
22. Coe, R.: What is an Effect Size. A Guide for User (2000).
23. Gunawan, G., Nisrina, N., Suranti, N.M.Y., Herayanti, L., Rahmatilah, R.: Virtual laboratory to improve students conceptual undestanding in physics learning. Journal of Physics: Conference Series, 1108 012049 (2018).

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.