16. Supporting scientific communication skills with multiple representations: Learning physics in the COVID-19 pandemic

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Supporting scientific communication skills with multiple representations: Learning physics in the COVID-19 pandemic

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Abstract

The Covid-19 pandemic forces students to study physics from home. Lecturers need to facilitate, so that the essence of physics learning objectives can be achieved. This study aims tosupport students' scientific communication with multiple representations. This research was conducted with a pre-test post-test design. The research was conducted on 30 students of IAIN Salatiga who program basic physics courses. The research data were analyzed using paired t-test (α = 5%) and gain test. The results showed that there were significant differences in students' scientific communication skills, between before and after being given learning supported by multiple representations. In general, students' scientific communication skills have increased with moderate criteria. the implementation of multi-representation becomes a real effort to involve students in learning scientific communication skills. it is necessary so that students succeed in learning and it is proven that students' scientific communication skills have increased.

Keywords: *Scientific Communication Skills, Multiple Representation, The Covid-19 Pandemic*

1. Introduction

The Covid-19 pandemic has an impact on education in Indonesia. The Indonesian Minister of Education and Culture made a policy for implementing online learning and working from home in order to prevent the spread of Covid-19 through letter number 36962/MPK.A/HK/ 2020. Students are required to study from home and lecturers to learn from home. Therefore, lecturers must be creative in designing and implementing learning so that learning objectives are achieved.

One of the competencies learned in physics is to communicate the results of scientific work scientifically. Therefore, scientific communication is important in learning physics. Scientific communication skills emphasize learning to understand and study language scientifically through applying learning principles, namely: assessing initial understanding, linking facts with conceptual frameworks, metacognitive monitoring, determining performance, and providing feedback (Baker *et al*., 2009). Scientific Communication Skills are skills in communicating the thinking process in learning physics both orally and in writing. Scientific communication skills in this study are the skills to communicate concepts that are understood verbally and non-verbally but still in learning physics. Sub-scientific communication skills, namely: (1) seeking information; (2) listening and observing; (3) scientific writing; (4) represent information; and (5) present knowledge (Levy *et al*., 2009).

Students need communication skills to explain valid conclusions based on scientific evidence in solving problems constructively (Santrock, 2011; Yusuf & Adeoye, 2012). Students can express their thoughts to others, both verbally and in writing (Adler & Rodman, 2006). Therefore, scientific communication skills remain important to learn even during the Covid-19 pandemic, and students must learn from home. This is because scientific skills will provide benefits to student life. Scientific communication skills allow students to sort and describe the thoughts and ideas of others systematically. Sequences and descriptions systematically allow others to grasp the ideas put forward as expected as the purpose of communication. Scientific communication learning emphasizes learning to understand and learn language scientifically through applying learning principles, namely: assessing initial understanding, connecting facts with a conceptual framework, metacognitive monitoring, determining performance, and providing feedback (Baker et al., 2009).

If students' communication skills do not develop, it will cause them to experience difficulties in compiling and describing thoughts and connecting ideas with other ideas. Therefore, efforts are needed that support the improvement of students' scientific communication skills. In this study, the effort made was to implement multi representations with the Investigation-Based Multiple Representation (IBMR) learning models. The IBMR learning model provides a learning experience by utilizing multiple representations in physics learning (Siswanto *et al*., 2018). The IBMR learning model has a syntax developed from Modeling Instructions and problem-based learning. Students are oriented to phenomena or simulations or demonstrations and the use of multiple representations, then carry out investigations, present the results of investigations with multiple representations, then applied to physics problem solving and evaluation.

The IBMR learning model is supported by constructivist learning theory and information processing. The investigative process of presenting with multi representations is supported by constructivist learning theory, while the application process for problem-solving is supported by information processing learning theory.

Multiple representations can help understand situations in-depth, helping to divert attention to something more than just manipulating equations (Maries, 2013). Multiple representations are usually used as a means of explaining and as a step in formal procedures. Multiple representation formats are verbal, picture/ diagram, mathematical, and graphical (Waldrip *et al*., 2010). The verbal format serves to define a concept. The mathematical format helps to solve quantitative problems based on qualitative representations. In the meantime, the image or diagram visualize the abstract concepts. The graphic format serves to help a long explanation of a physics concept. Each of these formats supports the communication of scientific work. Multi representation is expected to support students' scientific communication skills in learning physics during the Covid-19 pandemic.

2. Theories

2.1. Multiple Representation in physics learning

In physics learning, physics concepts or processes can be presented with various representations. Presenting the concept or process of physics in various representations can overcome difficulties in learning physics (Dolin, 2001). Therefore, students must be skilled in using representation mode.

Representation can represent, symbolize, or describe with a configuration (shape or arrangement) (Goldin, 2002). In line with that, Waldrip (2008) defines representation as something that describes, represents, or symbolizes an object or scientific process. Representation in physics learning consists of verbal representations, pictures, graphics, and mathematics (Waldrip *et al*., 2010).

The representation of physics concepts in various modes will help students understand the most appropriate and easily understood representation. The purpose of using multiple representations is to communicate more effectively or efficiently. Multi representation means representing the same concept using several modes of representation (Ainsworth, 1999; Waldrip *et al*., 2010; Sinaga *et al*., 2014; Haili *et al*., 2017).

Multiple representations function as instruments that provide support and facilitate meaningful and/or deep learning. Multi representation is also a powerful tool to help students develop their scientific knowledge. Therefore, using different representations and modes of learning will make concepts easier to understand and enjoyable (Ainsworth, 1999).

The meaning of learning can be reflected in the students' ability in scientific communication to solve. Working with multiple modes of representation and mentally switch between modes of representation are vital skills needed to provide scientific explanations of natural phenomena. In scientific communication, internal and external representations are influenced. The internal representation is a person's way of solving problems, keeping the internal components of the problem in his mind (mental model). Meanwhile, external representation is something related to symbolizing or representing objects and/or processes. In this case, representation is used to recall thoughts through description, imagery, or imagination and is used in scientific communication.

2.2. Scientific Communication Skills

Communication is done verbally or orally, which can be understood by both parties. However, if verbal communication cannot occur, both parties can do written communication to understand it. Non-verbal communication can be done by using gestures, showing certain attitudes, for example, smiling, shaking the head, shrugging shoulders. Communication aims to make the information conveyed by someone can be understood by others so that mutual understanding occurs, someone's opinion can be accepted by others, and to ask others to do something.

Some of the 21st-century skills that students must learn and master are creative thinking, innovating, critical thinking and problem-solving, or metacognitive thinking. They also need to develop skills in working, using information and technology, socializing locally and globally, and understanding personal and social responsibility (Griffin et al., 2012). One of the essential things for students to learn is scientific communication skills. Scientific communication skills emphasize learning to understand and study language scientifically.

Scientific communication skills help to describe thoughts and ideas systematically. The order and description in a systematic manner allow other people to grasp the ideas put forward as expected as the purpose of communication. Therefore, scientific communication learning emphasizes learning to understand and learn language scientifically through learning principles.

3. Methods

This research was conducted on 30 students of IAIN Salatiga who were joined basic physics courses on the topic of geometric optics. This study was classified as a pre-experimental study using one group pre-test and post-test design: O1 X O2 (Fraenkel & Wallen, 2012). The research emphasized multiple representation analysis to support students' scientific communication skills in the COVID-19 pandemic era. The research data analysis was carried out by calculating the mean pre-test and post-test scores with (a) paired-sample t-test (Gibbons & Chakraborti, 2011); and (b) calculating the mean n-gain with the following categories: (1) high if the n-gain is ≥ 0.70; (2) moderate if $0.70 >$ n-gain ≥ 0.30; and (3) low if n-gain <0.30 (Hake, 1998).

4. Findings & Discussions

The results of the pre-test and post-test of students' scientific communication skills are presented in Table 1.

Table 1
The pre-test and post-test scores of students' scientific communication skills

Test	Min	Max	Average	Normality (p - value)	Homogeneity (p - value)	Paired t-test
Pre	45.24	61.90	49.82	0.076 (Normal)	0.389	p <0.001
Post	72.50	88.67	78.78	0.200 (Normal)		

Table 1 shows a significant difference between the pre-test scores (before being given multi-representation learning) and the post-test scores (after being given multi-representation learning). After being given multi-representation, the average score of students' scientific communication skills supported learning through the IBMR model is better than before. Students' scientific communication skills have improved after being given learning supported by multiple representations. Furthermore, the increase in students' scientific communication skills for each indicator is presented in Table 2.

Table 2
N-gain of students' scientific communication skills

Indicators of scientific communication skills	Average		N-gain	
	Pre-test	Post-Test	Score	Criteria
searching for information	53.50	84.00	0.66	Moderate
scientific reading	52.00	82.50	0.64	Moderate
listening and observing	45.80	76.67	0.57	Moderate
scientific writing	50.20	78.88	0.58	Moderate
represents information	48.60	76.40	0.54	Moderate
present knowledge	48.80	74.20	0.50	Moderate
Average	49.82	78.78	0.58	Moderate

Table 2 shows that students' scientific communication skills improved by moderate criteria. Each indicator of scientific representation skills has increased with moderate criteria. This shows that multi representation supports the improvement of every indicator of communication skills. Representation format in learning a particular concept provides considerable opportunities to understand the concepts and communicate them and how they work with the system and the process of a physics concept (Meltzer & Shaffer, 2011). Representation formats in physics learning include verbal communication, pictures/diagrams, mathematics, and graphics representations (Waldrip et al., 2010). Each representation format support students in learning physics and scientific communication skills. Such skills are; seeking information, reading scientifically, listening and observing, scientific writing, representing information, and presenting knowledge.

During the COVID-19 pandemic, multi-representation became an effort to involve students in scientific communication skills. A conscious effort to involve students in learning is needed to succeed in learning (Bahtaji & Roleda, 2014; Sinaga *et al*., 2014). Scientific communication skills are trained through a multi-representational learning process at the orientation, investigation, multi representation, application, and evaluation stages. Students use verbal representations, pictures, mathematics, and graphics in their scientific work. These results are consistent with the cognitive constructivist theory that students will be actively involved in the process of obtaining information and constructing their knowledge (Piaget, 1964; Moreno, 2010). In addition, this is consistent with Vygotsky's constructivist social theory, which has four main implications, namely social learning, the zone of proximal development (ZPD), scaffolding, and cognitive apprenticeship. Social learning is that students learn through interaction with other people who are more capable of learning scientific communication skills. ZPD is the zone between the actual level of development shown by the ability independently and the level of potential development under the guidance of more capable people. Scaffolding, which is to provide sufficient assistance during the learning process in completing assignments, according to what students need. Cognitive apprenticeship is a process where students reach step-by-step expertise in their interactions with lecturers or other students who are more capable (Slavin, 2011).

5. Conclusions

This study concluded that the multiple representations used in physics learning during the Covid-19 pandemic could support students' scientific communication skills. Students' scientific communication skills have increased with moderate criteria after learning using multiple representations. Each indicator of scientific communication skills, namely: seeking information, listening and observing, scientific writing, representing information, and presenting knowledge, all improved with moderate criteria. So far, there has not been many research on representation format and its impact on each indicator of scientific communication skills. Therefore, further research can be carried out to examine this matter in depth.

References

Adler, R., & Rodman, G. (2006). *Understanding human comunication*. Oxford University Press.

Ainsworth, S. (1999). The Function of multiple-representations. *Computers & Education, 33*(2), 131-152.

Bahtaji, M.A.A., & Roleda, LS. (2014). *Improving transfer of learning through graphical representation*. De La Salle University Research Congress, Manila, Philippines.

Baker, D. R., Lewis, E. B., Purzer, S., & Lang, M. (2009). The communication in science inquiry project (CISIP): A project to enhance scientific literacy through the creation of science classroom discourse communities. *International Journal of Environmental & Science Education, 4*(3), 259- 274.

Dolin, J. (2001). Representation forms in physics. In D. Psillos, Kariotoglou, P. , Tselfes, V. , Bisdikian, G., Fassoulopoulos, G., Hatzikraniotis, E., Kallery, M. (Ed.), *Proceedings of the Third International Conference on Science Education Research in the Knowledge Based Society, Thessaloniki, Greece: Aristotle University of Thessaloniki*, 359-36.

Fraenkel, J.R, & Wallen, N.E. (2012). *How to design and evaluate research in education*. Mc.Graw-hill.

Gibbons, J. D., & Chakraborti, S. (2011). *Nonparametric statistical inference (5th edition)*. CRC Press.

Goldin, G. A. (2002). Representation in mathematical learning and problem solving in L D English (Ed). *Handbook of International Research in Mathematical. Education, Mahwah, NJ: Erlbauh,* pp. 197-218.

Griffin, P., McGaw, B., & Care, E. (2012). *The changing role of education and schools*. Springer Science Business Media.

Haili, H., Maknun, J., & Siahaan, P. (2017). Problem solving based learning model with multiple representations to improve student's mental modelling ability on physics. *Proceeding of AIP Conference,* pp. 1-7.

Hake, R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66* (1), 64-74.

Levy, O. S. B., Eylon, & Scherz. (2009). Teaching communication skills in science: Tracing teacher change. *The Weizmann Institute of Science Rechovot, 24*, 462-477.

Maries, A. (2013). *Role of multiple representations in physics problem solving* (PhD Dissertation, University of Pittsburgh). Retrieved December 14, 2017, from https://www.compadre.org/Repository/document/ServeFile.cfm? ID= 13052& DocID=3616.

Meltzer, D.E,. & Shaffer, P.S. (2011). *Teacher education in physics: Research, curriclum & practice*. American Physical Society.

Moreno, R. (2010). *Educational Psychology*. John Wiley & Sons Inc.

Piaget, J. (1964). Cognitive development in children: Development and learning. *Journal of Research in Science Teaching, 2*(3), 176 – 186.

Santrock, J. W. (2011). *Educational Psychology*. McGraw-Hill Inc.

Sinaga, P., Suhandi, A., & Liliasari. (2014). The effectiveness of learning to represent physics concept approach: preparing pre-service physics teachers to be good teachers. *International Journal of Research in Applied, Natural and Social Sciences, 2*(4), 127-136

Siswanto, J., Susantini, E., & Jatmiko, B. (2018). Practicality and effectiveness of the IBMR teaching model to improve physics problem solving skills. *Journal of Baltic Science Education, 17*(3), 381-394.

Slavin, R. E. (2011). *Educational psychology, theory and practice*. Pearson Education Inc.

Yusuf, F. A., & Adeoye, E. A. (2012). Developing critical thinking and communication skills in students skills in student: Implications for practice in education. *An International Multidiscplinary Journal Ethiopia*, *6*(1), 311-324.

Waldrip, B. (2008). Improving learning through use of representations in science. *Proceeding The 2nd International Seminar on Science Education*. UPI Bandung.

Waldrip, B., Prain, V., & Carolan, J. (2010) Using multi-modal representations to improve learning in junior secondary science. *Research in Science Education, 40*(1), 65 – 80.

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