INTERNATIONAL JOURNAL OF RESEARCH – GRANTHAALAYAH

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THE PRACTICALITY AND EFFECTIVENESS OF STUDENT WORKSHEET BASED MULTIPLE REPRESENTATION TO IMPROVE CONCEPTUAL UNDERSTANDING AND STUDENTS' PROBLEM-SOLVING ABILITY OF PHYSICS

Yani Suryani[*1], I Wayan Distrik[2], Agus Suyatna[2]

[1] Physics Education Department, University of Lampung, Jl. Prof. Dr. Sumantri Brojonegoro No. 1 35 145 Lampung, Indonesia

Abstract

This research aims to analyze the practicality and effectiveness student worksheet based on multiple representation to improve conceptual understanding and problem-solving ability, especially in magnetic material. The research method using quasi experiment with pretest-posttest control group design. The sampling technique used purposive sampling technique, class XII student high school in Bandar Lampung. The instruments are feasibility student worksheet of observation sheet, student responses to the student worksheet, student activity sheets, and conceptual understanding test and problem-solving ability test. Data were analyzed using descriptive analysis by percentage, N-gain analysis, and independent t-test. The results showed student worksheet based on multiple representation: 1) practical, which is indicated by a) the average score student worksheet enforceability in any learning activity that is 87.31 with very high criteria and b) the positive response of students (83.75%) against student worksheet. 2) effective, which is indicated by a) the student's activity during the study included in the active category, and b) there are significant differences in conceptual understanding and problem-solving ability between the experiment class and control class. Conceptual understanding and problem-solving ability are taught using student worksheet based on multiple representation the experimental class better than the control class.

Cite This Article: Yani Suryani, I Wayan Distrik, and Agus Suyatna. (2018). "THE PRACTICALITY AND EFFECTIVENESS OF STUDENT WORKSHEET BASED MULTIPLE REPRESENTATION TO IMPROVE CONCEPTUAL UNDERSTANDING AND STUDENTS' PROBLEM-SOLVING ABILITY OF PHYSICS." *International Journal of Research - Granthaalayah*, 6(4), 166-173. https://doi.org/10.5281/zenodo.1243075.

1. Introduction

Education is a lifelong need. Every human being needs education until whenever and wherever located. The rapid development of education certainly pose challenges, especially the selection of appropriate teaching materials and use of technology in education including challenges in physics. Physics is a branch of science. Science deals with how to find out about a natural phenomenon systematically. To explain the phenomenon, scientists built the concepts and theories that often uses abstract symbols so that it becomes difficult to understand. This makes most of the students are less fond a physics lesson at school. Not a few problems in physics particularly on abstract and complex material is very difficult to solve because many involve complex mathematics [1]. Thus in learning physics students are required to be able to build their own knowledge and actively participate in the learning process.

Based on the results of preliminary studies of high school students in Bandar Lampung, 81% of students have difficulty in learning the material magnetism and considers the matter so complicated and 83% of students use the symbolic representation in the form of a formula in problems solving physics. Whereas in studying the physics of matter is in need of conceptual understanding and student's ability to interpret various representations when solving problems. Ability to interpret a variety of representations, is needed to implement various concepts in solving the problems appropriately [2, 3].

Learning on the material magnetism main goal is to develop students' thinking skills to the overall magnetic material at both the macroscopic, microscopic and symbolic. Students' understanding of magnetic material is shown by its ability to transfer and links between the phenomenon of macroscopic, microscopic and symbolic. Inability to represent one of the three, will affect the other, so that students will have difficulty in solving the problems that are complex [4]. Explanation verbally through the text that has been created will be more easily understood if the description text is equipped with an image/visual and graphic corresponding to such materials. Students' individual differences may play a role in their interpretation of visuals on science assessments ([5, 6, and 7]). Students use representations to support understanding when they solve a problem or learn new concepts [8].

Representation is something that represent, describe, or symbolize objects and/or processes. Multiple representation (MR) means represent the same concept in a different format, including verbal, images, graphics, and mathematics [9]. According to [10] learning environment with multiple representation has three main functions, the first function is to use the representation to obtain additional information or support the process of cognition exist and complement each other. The second, representations can be used to limit the interpretation that may occur. And the third representation can be used to motivate the students to build a deeper understanding. Based on research by [11] that multiple representation used in interactive conceptual learning programs have high effectiveness in imparting conceptual understanding. The use of MR in learning can improve students conceptual understanding [12, 13]. Another similar study conducted by the [14] that the use of analogy and representation in learning more effectively improve students' conceptual understanding in electrical and magnetic materials.

The purpose of this research is to apply the learning to use student worksheet based on multiple representation to describe the increasing of students' conceptual understanding and problem

solving ability in terms of practicality and effectiveness in the magnetism learning process. Based on these goals, then formulation of the problem in this study, as follows.

1) How practicality student worksheet based on multiple representation magnetism learning?
2) How effectiveness student worksheet based on multiple representation magnetism learning?

2. Research Methodology

2.1. Research Design

This uses quasi-experimental design with product trials using pretest-posttest control group design. Data assessment results practicality shown by feasibility student worksheet and students 'responses to student worksheet form of qualitative data, while data on the results of the assessment of effectiveness demonstrated by the observation of students' activity in the form of qualitative data and test conceptual understanding and problem-solving abilities of physics students in the form of quantitative data which can be seen from the students' pretest and posttest scores.

2.2. Research Sample

The sample collecting technique is the purposive sampling, the sample are selected based on consideration of the researcher. The research sample to obtain the needs data analysis, the researchers involved 108 students and 5 teachers to fill a questionnaire. The test products in this study were taken one class taught by using student worksheet based multiple representation and other classes of the same level as the comparison taught by using conventional student worksheet.

2.3. Research Instruments

Instruments practicality consists of observation sheets feasibility student worksheet to determine the level of adherence to student worksheets in learning and sheets student responses to student worksheets obtained through a questionnaire consisting of 11 items, 8 items consisted of a questionnaire that required students to choose statements happy, quite happy, mediocre, and not happy. Then 3 items contain questions that require answers in the form of student opinion regarding student worksheet used. Prior to use the students' responses to the questionnaire student worksheet based on multiple representation validated by experts and is valid. Furthermore, the effectiveness of the instrument consists of pieces of observation of student activity during learning using student worksheet based on multiple representation and conceptual understanding test consists of six multiple choice questions reasoned and problem solving test consists of four essay questions were adopted from [4].

2.4. Data Analysis

Data analysis results practicality student worksheet descriptively. student worksheet practicality in terms of enforceability student worksheet based on multiple representation learning using REAL model and students' responses to student worksheet. Feasibility of student worksheet is determined by calculating the average score of every aspect, then the average score was transformed into value

with criteria. As for the reference conversion the score to a scale of five, according to [15] can be seen in Table 1 below.

Table 1: Conversion Score Rating Value Statement Quality Practicality

Level Accomplishment	Qualifying
81-100%	Very Good
61-80%	Good
41-60%	Sufficient
21-40%	Insufficient
0-20%	Very Insufficient

Analysis of the data from students' responses to student worksheet by way of happy and quite happy to be grouped in a positive response while the mediocre and not happy grouped in a negative response. Analysis of data to determine an improved students' conceptual understanding and problem solving skills using analysis inferential statistical analysis of t-test and analysis of the average score of *N-Gain* to determine the effectiveness of magnetic student worksheet based on multiple representation. Interpretation criteria *N-gain* from [16] as in Table 2.

Table 2: Criteria Interpretation of N-gain

Gain Value	Criteria Interpretation
$g > 0.7$	High
$0.3 < g \leq 0.7$	Medium
$\leq 0.3\ g$	Low

3. Results and Discussions

The Practicality of student worksheet based multiple representation measured through feasibility student worksheet in learning and students' responses to student worksheet. The feasibility student worksheet in learning includes learning activities that consist of material exposure, experimental activities, problem solving, and self-reflection. Results the feasibility of student worksheet observation can be seen in Table 3.

Table 3: Observations Feasibility of Student Worksheet Based Multiple representation

Pert.	Aspects Observation	Observer I	II	Average	Average Every Meeting
I	Step activities	87.00	72.00	79.50	85.23
	System social	100.00	71.00	85.50	
	Principles of reaction	89.50	70.00	79.75	
	Support Systems	100.00	90.00	95.00	
	Impact of instructional	90.00	82.75	86.38	
II	Step activities	88.25	89.25	88.75	87.20
	System social	89.00	80.00	84.50	
	Principles of reaction	95.00	80.00	87.50	
	support Systems	100.00	81.00	90.50	
	Impact of instructional	89.50	80.00	84.75	
III	Step activities	87.50	92.50	90.00	89.50

System social	100.00	85.00	92.50
Principles of reaction	85.00	80.00	82.50
support Systems	100.00	91.00	95.50
Impact of instructional	90.00	84.00	87.00
Average Score Feasibility of Student Worksheet		87.31	

Table 3 shows that the results of observation feasibility student worksheet on the first meeting until third with an average score of 87.31 was included in the very high category. This means that student worksheet based on multiple representation used have operational measures, social system, the principle of reaction, support system, and instructional impact are good. Learning activities using student worksheet based multiple representation REAL model gives an opportunity for students to understand and recognize the concept of a target by using the concept that has been owned by the students, by analogy or a similar concept. In learning by using student worksheet based multiple representation lead students to apply verbal representations, symbolic/formula, and visual to explain the concept of the target (magnetism).

Furthermore, the social system in the learning visible from the interaction between teachers and students when the teacher guides the students in formulating the concept target with the concept of analogy and the concept of a target through multiple representation, while the interaction between students and groups seen during the experiment, formulate hypotheses, analyzing data, concluded then deliver the opinion of each group. Then the students are guided apply concept to solve the problem. In solving the problem, students are given assistance in the form of an example of a similar solution to the problem is solved. Students also undertake reflection and self-assessment of the ability of its own. In this step, students perform a self-assessment, the shortfall on him in explaining the concepts and problem solving.

Students' response to student worksheet based multiple representation with REAL model can be seen in Table 4.

Table 4: The results of the Student Response Student Worksheet Based Multiple Representation

Response	Students
Positive	83.75%
Negative	16:25

Table 4 shows the results of students' responses to student worksheet based multiple representation used a positive response (83.75%). Most of the students (81.5%) was pleased to learn with multiple representation-based student worksheet, 79.75% of students expressed using multiple representation-based student worksheet easier to understand abstract concepts as developed student worksheet analogy is equipped with a target concept with a similar concept they have learned previously. These results support the findings of [17] which states analogy usage is not only improving understanding concept comprehensively, but also overcoming the misconception. Activities of students in learning to use student worksheet based multiple representation were active, because students are involved in every phase of activities ranging from phase to phase to explain the concept of the target reflection and self-assessment. These results are consistent with the results of research [18] student worksheet based RGM can increase students in learning activity and student retention in material.

The effectiveness of student worksheet based multiple representation in learning is measured through learning outcomes which consists of conceptual understanding test results and test results on the students' problem-solving abilities experimental class and control class. Based on the results of the analysis of conceptual understanding and problem solving skills of students in the experimental class and control class can be seen in Table 5.

Table 5: Results *N-gain* and different test Students' Conceptual Understanding and Problem Solving

Aspect		Pretest	Posttest	*N-gain*	Criteria	P
Concept Understanding	Experiment	13.67	77.30	0.737	high	0.001 *
	Control	7.80	50.70	0.465	Medium	
Problem Solving Ability	Experiments	39	50	0.54	Medium	0,000*
	Control	20	68.67	0.28	low	

* $p < 0.05$

Based on Table 5, the experimental class which used student worksheet based on multiple representation gain an increased conceptual understanding is higher than the control class that used conventional student worksheet. The results of Mann-Whitney analysis, there is an average difference was significant ($p < 0.05$) between the experimental class and control class. The high score of N-Gain conceptual understanding of the experimental class indicates that student worksheet based multiple representation used in the study had efficacy in the high category in instilling concepts in magnetic materials. The learning process by using multiple representation based learning sources has given opportunities for students to use their understanding of the representations that support when learning new concepts. Students' understanding of the material not just focus on one form of representation but in many representations that they get from the experiment contained in student worksheet. When using the forms of representation, understanding the concept of students have not been good, then use other representations will help students to better understand the concept. Thereby students concept understanding will be more profound. This is suitble with the opinion of [19] which states that multiple representation can support the construction of deeper conceptual understanding. The results of similar research conducted by [20] MR reveals that learning to effectively to improve students' conceptual understanding as well as to improve the knowledge of teachers to students' understanding. In addition, research [21] showed that training students to transform their acquired knowledge within and across various representational forms and to reflect on the scope and function of each level fosters their relational reasoning hence helps them develop a more integrated conceptual knowledge.

In the context of overall service to all students, usage student worksheet based multiple representation also very supportive. This is consistent with the data in the field, that students have different intelligence among the students of the other students. There is more prominent students verbal ability, there are the more prominent the ability of the formula, and there are more prominent visual and graphic capabilities. Student worksheet views based multiple representation to explain the concept of magnetism has provided opportunity to all students to be able to understand the concept in accordance with their specific abilities.

Table 5 also shows the average score of *N-Gain* experimental class (0,54) and control class (0,28). This means both classes which used student worksheet based multiple representation and

conventional student worksheet have an increased in the problem-solving ability, but based on the results of the analysis of different test, a significant difference (p <0.05) on average between problem-solving abilities experimental class and control class. Learning by using student worksheet based on REAL multiple representation the third phase of guiding students to apply the concepts used in problems solving. Stages of problem solving begins with the featured models, either verbal or visual, then the students analyze the problem in accordance with the model shown both visual or formula to resolve the problem. In the final stage the students perform verification or validation to the problem based on the calculation. At each stage of problem solving is seen that the use of various forms of representation appears. This was confirmed by research conducted [22, 23, and 24] who found multiple representation plays an important role in solving the problem.

4. Conclusions & Recommendations

Based on the description in the discussion can be concluded that student worksheet based multiple representation using REAL model, 1) practically be seen from the results feasibility of student worksheet in learning and positive students' response against student worksheet. 2) effective be seen of students activities during the learning included in the active category, and there are significant differences in conceptual understanding and problem solving skills between the experimental class and control class. Students' conceptual understanding and problem solving skills are taught using the experimental class student worksheet based multiple representation better than the control class. Multiple representation assist students in learning physics concepts in a comprehensive manner in accordance capabilities of students.

References

[1]   Mur, J., Zaragoza, M. L., Usón, A., Letosa, J., Samplón, M., & Artal, S. J. (2004). Teaching Electricity and Magnetism in electrical engineering curriculum: applied methods and trends. *International Conference on Engineering Education*, *50018*, 1–11.

[2]   Kohl, P. B., & Finkelstein, N. D. (2006). Effects of representation on students solving physics problems: A fine-grained characterization. *Physical Review Special Topics-Physics Education Research*, *2*(1), 1-12.

[3]   Ali DELÌCE & EYüp SEVÌMLÌ. (2010). An investigating of the pre-services teachers' ability of using multiple representation in problem-solving Success: the case of definite integral. *Educational Sciences: Theory & Practice, 10* (1), 137-149.

[4]   Distrik, I. W. (2016). *Model Pembelajaran "REAL" untuk meningkatkan kemampuan metakognisi pemahaman konsep, dan metakognisi listrik dan magnet pada siswa calon guru fisika.* Disertasi Universitas Negeri Surabaya.

[5]   LaDue, N. D., Libarkin, J. C., & Thomas, S. R. (2015). Visual representations on high school biology, chemistry, earth science, and physics assessments. *Journal of science education and technology*, *24*(6), 818-834.

[6]   Suyatna, A., Anggraini, D., Agustina, D., & Widyastuti, D. (2017). The role of visual representation in physics learning: dynamic versus static visualization. In *Journal of Physics: Conference Series*, 909 (1), 012048.

[7]   Qasim, S. H., & S. S. Pandey. (2017). Content analysis og diagramatic representation in upper primary science textbooks. *International Journal of Research-Granthaalayah,5* (7), 474-479.

[8]   Van Heuvelen, A., & Zou, X. (2001). Multiple representations of work–energy processes. *American Journal of Physics*, *69*(2), 184-194.

[9]   Waldrip, B., Prain, V., & Carolan, J. (2006). Learning junior secondary science through multi-modal representations. *Electronic Journal of Science Education*, *11*(1), 87-107.

[10] Ainsworth, S. (2008). The Educational Value of Multiple-Representations when Learning Complex Scientific Concepts. *Visualization: Theory and Practice in Science Education*, 1–15.

[11] Suhandi, A., dan F. C. Wibowo. (2012). Pendekatan Multirepresentasi Dalam Pembelajaran Usaha-Energi dan Dampak Terhadap Pemahaman Konsep Mahasiswa. *Jurnal Pendidikan Fisika Indonesia. 1*(8), 1-7.

[12] Abdurrahman*, Liliasari., A Rusli, & B Waldrip.* 2011. Implementasi Pembelajaran Berbasis Multirepresentasi untuk Peningkatan Penguasaan Konsep Fisika Kuantum. *Cakrawala Pendidikan, jurnal ilmiah pendidikan.* 30(1): 30-45.

[13] Hand, B., Gunel, M., & Ulu, C. (2009). Sequencing embedded multimodal representations in a writing to learn approach to the teaching of electricity. *Journal of Research in Science Teaching*, *46*(3), 225-247.

[14] Distrik, W., Budi, J., & Z. A. Imam, S. (2015). The Roles Of Analogy And Representation In Improving Concept Understanding On Electricity And Magnetism. *International Conference on Education Research and Innovation.* 370-376.

[15] Arikunto, Suharsimi. 2016. *Dasar-dasar Evaluasi Pendidikan Edisi 2.* Jakarta: Bumi Aksara.

[16] Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. *American journal of physics*, *70*(12), 1259-1268.

[17] Yılmaz, S., & Eryılmaz, A. (2010). Integrating gender and group differences into bridging strategy. *Journal of Science Education and Technology*, *19*(4), 341-355.

[18] Mahardika, I. K., Subiki, & Siti M. (2017). Momentum and impulse learning helped by worksheet based RGM to SMA by using PBL model. *International journal advanced research, 5(9),* 348-352.

[19] Mayer, R. E. (2003). The promise of multimedia learning: using the same instructional design methods across different media, learning, and instructional. *Journal learning and instruction,* 13 (1): 125-139.

[20] Prain, V., Tytler, S., Peterson, S. (2009). Multiple Representation in Learning About Evaporation. *International Journal of Science Education*, 31, 787 – 808.

[21] Jaber, L. Z., & Saomauma, B. (2012). A macro-micro-symbolic teaching to promote relational understanding chemical reactions. *International Journal of Science Education,* 34 (7), 973-998.

[22] Güler, G. (2011). The visual representation usage levels of mathematics teachers and students in solving verbal problems. *International Journal of Humanities and Social Science*, *1*(11), 145–154.

[23] Madden, P. S., Loretta, L. J., & Jrène, R. (2011). The role of multiple representation in the understanding of ideal gas problems. *Chemistry Education Research and Practice,* 12, 283-293.

[24] Distrik, W. (2011). Understanding Concepts and Problem Solving Ability Student of Physical Education, University of Lampung, Indonesia. *Proceding seminar Nasional Pendidikan 27 Februari 2011, ISBN 978-979-8510-11-3.*

*Corresponding author.
E-mail address: suryaniyani54@ gmail.com