Development of Studrnt Work Sheets Based on Analogy Content in Physical Learning to Improve Critical Thinking ability of High School Students

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Abstract

The purpose of this study is to produce a physics student worksheet based on analogy of content to rotational motion material and to find out the validity of the product being developed. This research uses R & D research procedures. In the development stage, a validity test was conducted by 2 experts namely design experts and material experts, then continued with the practicality and effectiveness test of student workseets conducted by 24 students of class XI IPA SMA. The results of the material expert validation received a value of 83.5% in the "very feasible" category. Then the design expert validation results got a value of 95% with the category "very feasible". Based on the results of the physics worksheet based on analogy of content from the aspects of design and material has valid criteria and is suitable for use. Then the practicality of the analogy-based physics student workseets content received a positive response of 89%. And the effectiveness of physics student workseets based on analogy of effective content improves students' critical thinking skills based on the results of the experimental class that obtained a Gain of 0.6 higher than the control class with a Gain of 0.2.

Keywords: Teaching materials, physics student worksheets, Analogy content

Introduction

Physics lesson as one of the lessons considered difficult by students, in fact theaching this material is still mostly using conventional methods or teacher-centered. Teaching and learning activities still make students as passive learning objects. Whereas physics learning is not just conveying concepts, facts, or principles by merely giving material by lecturing. Physics learning will be more memorable and felt real if students are directly involved in the learning process (Rahmawati et al, 2014). This is in accordance with the opinion of Abdurrahman et al (2011) where physics as a subject in schools still gets a bad reputation, which is difficult to learn and is not demand by most students.

Physics learning that is not balanced with the process of practicing thinking skills will cause students only be able to absorb cognitive learning outcomes in aspects of C1, C2, and C3, while for higher-order thinking skills (C4, C5, and C6) become neglected. Higher-order thinking skills of students must be trained to develop students' thought processes by stimulating their way of thinking in solving problems to build a concept (Nasir et al., 2015). Therefore, teachers always try to organize quality learning process so that students can achieve maximum learning achievement (Gunawan, et al., 2013). One of the teaching materials that can be used as a tool in organizing a quality learning process is the student worksheet.

Through student worksheets, students can independently carry out learning activities, student worksheets is also a companion and guide for students in carrying out learning activities. With worksheets students can learn in applying what they have learned (Kibara, 2010). Learning using student worksheets is also effective in improving learning outcomes of students' knowledge, attitudes and abilities in the learning process (Annafi, 2015). Student worksheets are a means of student learning activities, material summaries and questions. According to (Choo, 2011) worksheets are instructional tools consisting of a series of questions and information designed to guide students to understand complex ideas because they work through systematic systems.

In the process of learning physics it requires activities and teaching materials that can support and stimulate students to more understand what they are learning and stimulate students' critical thinking towards learning.

The ability to think critically is needed in the education development today. According to Syah et al (2016) critical thinking skills have a very strategic role in building students' mental abilities in dealing with their problems. In connection with learning science especially physics, students are not only required to understand the concepts alone, but furthermore students can have the ability to think critically. The ability to think critically is very important to be developed, because it will direct the pattern of action of each individual in his community later (Carlgren, 2013; Tiruneh et al., 2014).

Based on observations made at 3 high schools in Baradatu, both teachers and students are known that many students often experience difficulties in understanding physical material because of its abstract and difficult to understand concepts. From the observation of 3 physics teachers, it was found that 100% of teachers still often applied conventional learning in delivering difficult physics material, compared to other learning models and 100% of teachers did not make their own worksheets for learning activities. While observations made on 25 students found that 76% of students claimed they often had difficulty understanding physics learning because the concepts were abstract and difficult to understand and 84% of students stated that physics was difficult to understand because there were too many formulas in it.

The ability to think critically according to Kariadinata (2012) can be trained by doing by analogy. Analogy Content based on student worksheets is one of the teaching materials that is complemented by learning models that can be used by teachers in stimulating students' critical thinking skills. Based on these descriptions, researchers have made improvements to these conditions by developing a product in the form of content analogy based worksheets that can improve students' critical thinking skills and foster positive student attitudes.

1. Research Methods

This research uses the Sugiyono R&D model. In this research development researchers limit research only to stage seven because of the limitations of time and cost. The development research phase carried out are (1) potential and problems, (2) data collection, (3) product design, (4) design validation, (5) product revision, (6) product trial, (7) design revision . Research developed by researchers is to produce a material in the form of physics LKS based on analogy of content on rotational motion material.

At the potential and problem stage the researcher made observations using a few samples of the teacher in 3 different high schools found in Baradatu and 25 students from SMA Negeri 1 Baradatu. A needs analysis is carried out to gather information about what students and teachers need in particular, and schools in general. After knowing the potential and problems that exist in the study. Then the researchers collected information which was carried out with literature reviews from various sources such as the latest research journals and several books that support the research.

The physics worksheet design is compiled with an analogy learning model, where the analogy used is content analogy, specifically the worksheet contains analogy stages by finding content equations in translational motion and rotational motion material. In this worksheet, students learn to look for relationships between translational movements that students have learned in class X, and relate the material to the rotational motion that students have just learned. The product validation consists of design expert test (construction) and material expert test (content). The instrument used in the validation of this design is to use a questionnaire instrument. The expert test questionnaire instrument was used to assess and collect data about product viability. Validation test data analysis techniques were given to three experts in their fields by filling out questionnaires in the columns "STS", "TS", "S", and "SS". Revisions were made to the question content and experts provided specific input to the devices that had been made.

The product revision is carried out after the validation of the construction expert, material expert and one-on-one test, then the discrepancies or errors in the products made from the construction component, substance component, and effectiveness are known. Furthermore, improvements were made according to the advice and input provided by experts. After going through an assessment by a construction expert and material, the next stage involves students of class XI of SMA Negeri 1 Baradatu as research subjects. Then students are given questionnaire instruments to collect data on the level of product attractiveness and test instruments to test the effectiveness of the product. Product practitioner data is obtained from the test of attractiveness and effectiveness of the product to students after using the product in learning.

The data analysis technique is done by: coding or classifying data, tabulating data, member score respondent answers, where the attractiveness test questionnaire has 4 answers according to the question content, namely "STS", "TS", "S", and "SS" . Scoring the respondents' answers in the attractiveness test using teaching materials based on the percentage of the number of answers based on the Likert scale in Table 1.

Table 1. Scoring Ratings for Answer Choices

Choice of Answer	Choice of Answer	Choice of Answer	Choice of Answer	Score
Very good	Very suitable	Very easy	Very useful	4
Good	Appropriate	Easy	Helpful	3
Less good	Less suitable	Less easy	Less useful	2
Not good	Not suitable	Noteasy	Not useful	1

While the analytical technique for the effective use of content analytic worksheets based on learning uses assessment based on N Gain analysis. N-gain is obtained from the reduction in the value of the pretest with the posttest divided by the maximum score that is less by the pretest score. These values are classified in Table 2.

Table 2. Average Value of Normalized Gain and its Classification.

Normalized gain average	Classification	Effectiveness Levels
(g) ≥ 0,70	High	Effective
0,30 ≤(g) < 0,70	Medium	Moderately effective
(g) <0,30	Low	Less Effective

2. Results and Discussion

a. Research result

1) Requirement Analysis

Based on the analysis of 3 physics teachers from 3 high schools in Baradatu sub-district and 25 students from Baradatu 1 High School, it is known the potential and problems related to teaching materials. There are several potentials that have been analyzed by the researcher, namely teachers can make their own teaching materials in the form of worksheets in schools, but only 33% make worksheets to support physics learning. Another potential in the school where researchers conducted preliminary research is students that 84% of students claim physics is difficult because there are too many formulas, but on the other hand 72% of students also admit that formulas are also very helpful in understanding concepts. Therefore, researchers have developed worksheets that can help them understand physics formulas more easily, namely by analogizing translational motion to rotational motion.

2) Product Planning and Design

This design phase is the researcher makes a plan, which consists of teaching needs, material scripts, test instruments, and assessment instruments. Material manuscript requirements include syllabus, Learning Implementation Plan (RPP) and teaching material products in the form of Student Worksheets (LKS) based on content analogy. Test instruments include questions consisting of pretest and posttest, key answers and discussion of questions. While the assessment instruments are in the form of questionnaires for material experts, media experts and student responses.

3) Development of Product Draft

The initial product development stages that have been developed by researchers are as follows: (1) Content analysis: at the content analysis stage or Physics learning material used in the student worksheets that are developed, the researcher conducts a literature review on several Physics books that are compatible with the 2013 Curriculum that is the Teacher's Book and Student Books that have been provided by Kemendikbud 2013 and other textbooks that have been circulating. The subtopic that is considered appropriate by researchers for the development of physics LKS based on analogy of content is rotational motion.

(2) preparation of LKS: the presentation of Physics LKS is arranged in a sequence consisting of three parts, namely the front, contents, and closing. The front part consists of a cover, preface, and table of contents. The contents section consists of basic competencies, learning objectives, identity, work instructions, preliminary activities, learning activities and the concluding section in the form of questions. The final part of the physics analogy worksheet based on content consists of bibliography and the back cover contains the author's profile.

4) Preliminary Field Test

At this stage an initial trial of product design is carried out on a limited scale, namely the expert validation test. The validator 1 chosen by the researcher was the FKIP Unila lecturer and the Validator 2 chosen by the researcher was the FKT Unila lecturer who was an expert in the material and design fields. LKS validation test results obtained from the aspect of content obtained an average score of 84% which means very high. For the construction aspect, the average score of 97% is very high.

5) Product Revision

Based on the expert validation test, there are a number of suggestions for overall improvement of the physics LKS based on the analogy of the content of the two validators as follows: (1) aspects of the feasibility of graphics according to BSNP so that the utilization of the page can be optimized so that there are no useless pages / empty spaces; (2) complete the description of drawings, suggestions and illustrations on the worksheet. Based on the suggestions from the two validators, the researchers improved the physics worksheet based on the analogy of the content as suggested.

6) Large Field Test

After students use the worksheets results of student development are asked to fill in the attractiveness questionnaire. At the product trial stage, researchers took trial samples at 1 school. The recapitulation results of filling out a product trial for the attractiveness test can be seen in Figure 1.

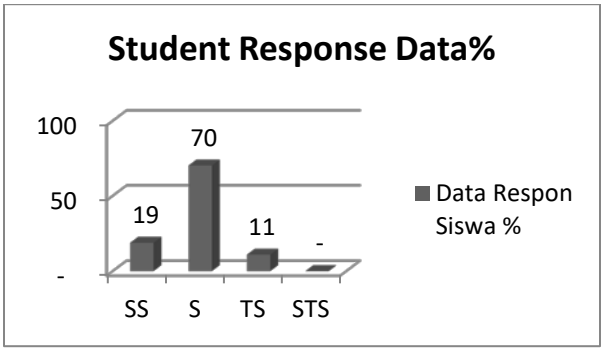

Figure 1. Student Response Graph Towards LKS Achievement

Based on Figure 1, it can be seen that students' attitudes and responses to the attractiveness of LKS in helping students understand the material of rotational and translational motion simultaneously. From Figure 1, it can be seen that the responses of students who strongly agree with the content analogy based LKS are 19%, 70% agree, 11% disagree and 0% strongly disagree. Based on these data, it can be seen the positive responses given by students to the use of content based analogy worksheets in rotational motion.

The effectiveness of physics LKS based on analogy of content is obtained from the N Gain value of students pretest and posttest results. The criteria of students completeness are determined in accordance with the minimum completeness criteria based on the reference of the minimum school completeness criteria for physics subjects, which is 70. Following the results of the pretest and posttest that have been obtained the results in Table 3.

Table 3. N Gain Results

		Results	N Gain	Effectiveness Level
Experiment	Pretest	34,7	0,6	Quite effective
	Posttest	73,3		
Control	Pretest	35,2	0,2	Less effective
	Posttest	58,1		

Based on the data in Table 3, the results of statistical analysis in the experimental class shows that the *N-gain* value is 0.6 with a sufficient level of effectiveness

effective, while the control class's *N Gain* value is 0.2 this shows included in the less effective category. From the two *N Gain* values can be known that both classes have increased grades, but the experimental class with using physics LKS based on analogy of content has a level of effectiveness higher than the class of dick that uses LKS without analogy content.

Then the students' pretest , posttest and *N-Gain results* were analyzed to determineis there an important difference between before and after doing learning with physics LKS based analogy to content on rotational motion and translation in high school. After processing the data, the data obtained at Table 4.

Table 4. Difference Test Results

		N	*Sig. (2-tailed)*
Experiment	Pretest & Posttest	28	0,00

Based on the significance value (2-tailed) from Table 4, the results of the analysis in the experimental class are 0.00 ($p < 0.05$), this shows that the confidence level is 95%, there is a significant difference between the values achieved in the experimental class ($0.00 < 0.05$). This means that differences in treatment using

worksheets in the experimental class have been shown to improve student learning outcomes. In other words the results of statistical tests show that H0 is rejected and H1 is accepted, namely there is a significant increase in students 'critical thinking skills after using analogy-based physics worksheets to improve students' critical thinking skills.

Based on the explanation that has been explained above it can be said that the worksheets developed already reflect good teaching materials and are suitable for use in the learning process. Analysis of the average learning outcomes using a physics LKS based on analogy of content based on the posttest scores obtained by students can be seen in Figure 2.

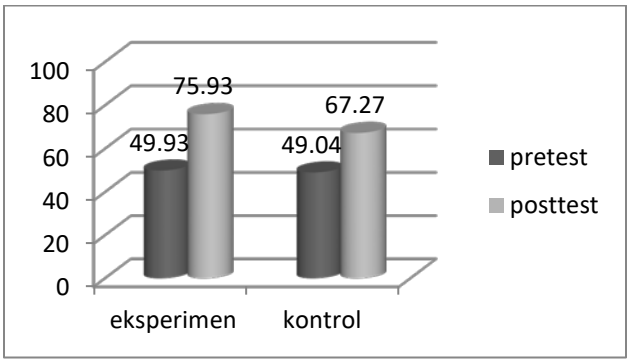

Figure 2. Mean results of pretest and posttest

Based on Figure 2, obtained an average of pretest both control and experimental classes have an average value that is not much different, namely 49.93 for the experimental class and 49.04 for the control class. While the posttest learning outcomes for the control class were 67.27 while the average posttest for the experimental class was 75.93. Therefore it can be stated that there is a difference between the experimental class applying the analogy-based physics LKS compared to the control class applying the physics LKS without the analogy of content.

b. Discussion

1) Validity of LKS

The validity of LKS in this study was seen based on the results of LKS analysis by 2 experts namely material experts and design experts. The validator is asked to assess the construct (design) and the content (material) whether the worksheet is appropriate or not, so that weaknesses and strengths can be identified. The results of the validity of LKS are still rational, because validation is still based on expert thinking, not in the form of facts in the field.

LKS teaching materials developed from the feasibility of the content are in accordance with BC KD and material depth. As according to Saidah et al (2014), the results of validation can be achieved if the teaching material has a link between the material with IC and KD as well as the suitability between teaching material and KD that students must master. The suitability of the worksheet design based on the worksheet size and the content design worksheet also meet the eligibility criteria. This is in line with the opinion of Saidah et al (2014) that good teaching materials (LKS) are teaching materials that are written using good language and are easily understood, presented attractively and are equipped with pictures and explanations.

Physics worksheet based on analogy of content developed has been tested for validity or feasibility based on expert judgment, because worksheets with unclear content or the possibility of concept errors in worksheets will cause students to be confused and will hinder the learning process. This is also supported by the opinion of Widjadjanti (2008) which states that in order to measure the quality of the worksheets, it is necessary to conduct an assessment by those who are considered competent so the results can be accounted for. The results of the

development worksheet have been tested for validity and the results of the validity are very decent, but it cannot yet be said to have achieved maximum results because there are still few suggestions for improvement.

a. The Winning of Physics Worksheet Based on Analogy of Content

Assessment of attractiveness of worksheets can be seen from the responses or responses of students. Based on the attractiveness analysis, the worksheets that were developed were categorized as good by looking at some indicators of student responses and the suitability of the material. This content analogy-based LKS physics teaching material is interesting because of several factors namely the stages of analogy in learning activities able to foster positive attitudes such as active and critical because LKS is easy to understand, not boring, arousing motivation in learning, the language is easy to understand and be clarified with pictures and can understand two materials simultaneously so that students more easily accept the material being studied.

The attractiveness of LKS is one of the factors that can attract students' attention. This is in line with what was expressed by Putrizal et al (2015) in her research that the attractiveness of student worksheets was seen from the assessment of performance, teacher's assessment, and student responses. This is supported by the statement of Saidah et al (2014) in his journal saying that the good response of students refers to feeling happy towards the learning process. Student interest in the learning process is an important factor and cannot be underestimated. Most of the attention of students will be focused on the learning process if students are interested in learning, students will be more active and provide a positive response.

In the physics learning process required adequate and appropriate supporting factors so that learning conditions can be created properly. One of the supporting factors is teaching material (Oktarinah, et al; 2016). The availability of analogy-based physics worksheets that are in line with the learning objectives can make it easier for teachers and students to carry out teaching and learning. In this case the practical aspects of developing LKS are very important in order to help and provide ease of use. This is also supported by the study of Sudarmi, et al (2015) that LKS is needed as a tool that can provide convenience and support teachers in achieving learning goals.

b. Effectiveness of Physics Worksheet Based on Analogy of Content

The results of the analysis of the effectiveness of the worksheets developed were reviewed in terms of the student learning outcomes fulfilling the criteria well, the results exceeded the Physics KKM class XI even semester of 70. The posttest results showed that the average score of the experimental group was greater than the control group. That is, the difference in treatment, namely the use of worksheets in the experimental group has been proven to be real improve student learning outcomes.

The effectiveness of worksheets was obtained based on different test results from the results of the pretest posttest in the experimental class. Based on the different test it can be seen that there is a significant difference between the pretest and posttest scores in the experimental class which shows that there are differences in learning outcomes before and after using analogy-based physics LKS content. These results indicate that in classrooms where learning using physics analogy-based worksheets is effective in improving students' thinking abilities. This was revealed by Putrizal et al (2015) that the effectiveness of worksheets can be seen from the results of assessments of student activity, self-efficacy, and increased mastery of concepts. Based on the effectiveness of the field test, the products produced are included in the very feasible category.

Based on the explanation above it can be said that the worksheet developed has benefits as teaching material in the learning process where the teaching material can clarify the meaning of the learning material so that the material can be better understood by students and enable it to master and achieve learning objectives so that the worksheet developed can be effective in help students understand physics more deeply. Understanding

can be obtained by practicing thinking skills by students in learning. This is in line with the opinion of Syahbana (2012), he revealed that with the lack of a tradition of critical thinking in schools, students are not accustomed to solving problems that require critical thinking, and finally the value of critical thinking skills is also low.

The worksheets developed also managed to get positive responses from students, this can be seen from> 80% giving a good or positive assessment of aspects of the worksheet in student questionnaire responses. Posttest result data also showed that the average score in the experimental class was greater than the control class. This can be seen from the posttest results of students in the experimental class having an average above the KKM (≥70). Posttest result data also shows the average score of the experimental class is greater than the control class with a confidence level of 95% which means there is a significant difference between the values achieved by the control class and the experimental class.

Based on the data and explanation above, it can be said that learning using physics analogy worksheet based on effective content analogy can improve students' critical thinking skills. According to Sannah et al (2015), effectiveness is also influenced by the attractiveness of LKS. This is in line with research Ellinawati, et al (2012) that the development of physics teaching materials can improve the ability to learn self-study, so as to develop students' critical thinking skills. critical can be: analyzing the relationship between several things, determining the cause of an event, and evaluating about something.

3. Conclusions and Suggestions

a. Conclusion

Based on the results of this development research are: (1) Physics worksheet based on analogy of content that has been developed from the aspect of content and construction has valid criteria and is suitable for use; (2) The attractiveness of analogy-based Physics Worksheet based on content to improve students' critical thinking skills in physics learning that is developed meets the criteria both in terms of students' responses to the questionnaire given and (3) The effectiveness of analogy-based worksheet based content has been effectively developed in improving students' critical thinking skills evidenced from the results of the posttest which showed the average score of the experimental class was higher than the control class.

b. Suggestion

Suggestions from this development research, better field testing should be done to determine the effectiveness of the product being developed. The product developed is in the form of analogy-based physics worksheets, so before applying it the teacher must really understand the use of analogies in learning.

4. Bibliography

Abdurrahman. 2015. *Science Teacher as Innovator (Designing Science Learning Innovative Research Based)* . Yogyakarta: Academy Media.

Annafi, N. 2015. Development of Inquiry-Based Student Activity Sheets Supervised by Thermochemical Material Class XI SMA / MA. *Journal of Inquiry* . 4 (3).21-28.

Carlgren, T. 2013. Communication, Critical Thinking, Problem Solving: A Suggested Course for All High School Students in the 21st Century. *Interchange* . 1 (44). 63-81.

Choo, S. 2011. Effect of Scaffolds Worksheet on Student Learning in Problem-Based Learning. *Advances in Health Sciences Education* . 16 (4). 517-528.

Ellianawati. 2012. Development of *Self-* Based Mathematical Physics Teaching Materials *Regulated Learning* as an Effort to Improve Independent Learning Ability. *Indonesian Journal of Physical Education. 8* (1). 33-40.

Gunawan; Setiawan, A & Widyantoro, DH 2013. Model Physics Virtual Laboratory Modern Teachers to Increase Generic Science Skills for Prospective Teachers. *Journal entry Education and Learning* . 20 (1). 25-32.

Kariadinata, R. 2012. Growing Power of Reason *(Power Of reason)* Students through Mathematical Analogy Learning. *Infinity Journal* . 1 (1). 1-9.

Kibara, Z. 2010. Developing a Worksheet about Physical and Chemical Events. *Procedia Social and Behavioral Sciences.* 2 (2). 739-743.

Nasir, M; Harjono, A & Sridana, N. 2015. The Effects of Using Learning Integrated Generic Science LKS (ITGS) against Physics Learning Outcomes Judging from the Student Achievement Motivation at SMAN 1 Aikmel. *Research journal Natural Sciences Education (JPPIPA).* 1 (1). 78-90.

Oktarianah; Wiyono, K & Zulherman. 2016. Development of Teaching-Based Materials Project Learning Model Material Optical Devices for Class X High School. Journal of Physics Innovation and Learning. 3 (1). 1-7

Putrizal, I; Sunyono & Efkar, T. 2015. LKS Mmateri Electrolyte and Non Solution Multiple Representation-based Electrolytes Using Simayang Models. *Journal of Chemistry Education and Learning* . 4 (1). 236-247.

Rahmawati, D; Nugroho, S & Putra, M. 2014. Application of Learning Models Cooperative *Type Numbered Head Together* Experiment Based for Improving Middle School Student Science Process Skills. *Unnes Physics Education Journal.* 3 (1). 40-45.

Saidah, N; Parmin, P & Dewi, NR 2014. Development of Integrated Science LKS Problem Based Learning Through Lesson Study Ecosystem and Theme Environmental Conservation. *Unnes Science Education Journal*. 3 (2). 549–556.

Sannah, I. K; Kadaritna, N & Tania, L. 2015. Development of LKS with Models *Discovery Learning* on Bohr's Atom Theory Material. *Journal of Chemical Education*. 4 (1). 184-196.

Sudarmini, Y., Kosim, & Hadiwijaya, A. 2015. Inquiry-Based Physics Learning Guided by Using LKS to Improve Skills Critical Thinking Reviewed from the Scientific Attitude of Madrasah Aliyah Qamarul Students Huda Bagu, Central Lombok. *Journal of Science Education Research (JPPIPA)* , 35-48

Shah, F. F; Haryani, S & Wijayanti, N. 2016. *Team Assisted Individualization* with Structured Exercise Methods to Improve Critical Thinking Skills. *Journal of Innovative Science Education.* 5 (1). 10-18.

Syahbana, A. 2012. Increased Mathematical Critical Thinking Ability of Middle School Students Through the *Contextual Teaching And Learning* Approach . *Edumatica: Journal Mathematics Education* . 2 (1). 45-57.

Tiruneh, DT. 2014. Effectiveness of Critical Thinking Instruction in Higher Education: A Systematic Review of Intervention Studies. *Journal of Higher Education Studies* . 4 (1). 1-17.

Widjajanti, E. 2008. Quality of Student Worksheets. *Training Seminar Paper Preparation of Student Worksheet for Vocational School / MAK Teachers in Community Service Activities Community Education Department of FMIPA State UniversityYogyakarta.* Yogyakarta: UNY