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The Impact of 7E Learning Cycle-Based Worksheets Toward Students Conceptual Understanding and Problem Solving Ability on Newton's Law of Motion

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Abstract. This research aimed to analyze the practicality and effectiveness of student worksheets on Newton's Law material to improve conceptual understanding and problem solving ability. This study uses pretest-posttest with control group design. Questionnaires and Newton Law of Motion Conceptual Survey (NLMCS) were used as the instruments. The questionnaire was used to collect observational data on implementation and student responses, while NLMCS was used to collect data of the conceptual understanding and problem solving ability. The results of observations and positive responses of students to learning activities using worksheets showed a score of 83% in the excellent category. The results of students' understanding of NLMCS in the experimental class using 7E learning cycle worksheet showed higher *N-gain* values (g=0.66) than the control class (g =0.55) as well as students problem solving abilities of students in the experimental class showed higher *N-gain* value (g =0.64) than the control class (g =0.28). Overall, the results of the study indicated that 7E learning cycle student worksheet developed was practical and effective to improve conceptual understanding and problem solving ability in Newton Law of Motion topics.

Keywords: conceptual understanding, learning cycle 7E, problem solving ability, students' worksheet

INTRODUCTION

Physics is one of the disciplines of science that is very rapidly developing, both in terms of material and its usefulness. As part of Natural Sciences, Physics discusses many of the symptoms and behavior of nature that can be observed by humans, as well as their application in life. Through Physics, students are invited to be able to understand various symptoms and problems, think, analyze, and be able to solve problems (Nursita et al., 2015). Problem solving means getting involved in a task whose solution is unknown beforehand. Good problem solvers analyze the situation carefully (Akinsola, 2008).

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Physics learning involves concepts that are sometimes difficult to understand. There are several methods which can be implemented by teachers in teaching Physics i.e. using models / strategies/approaches, modules, or student worksheets. But in reality Physics learning in the teacher class still uses methods that are not in accordance with needs. The fact that happened in the field, one of them is the high school in OKU Timur district, Indonesia, showed that there were still many teachers in the Physics learning process in schools who did not pay attention to the characteristics of Physics as a process that enabled students to be active in learning. There were 64.29% of students who stated that the teacher still used the lecture method. Learning that takes place in schools is more teacher-centered so students don't get an active opportunity in the learning process. 96.43% of the learning process at Senior High School in OKU Timur district only uses printed books. Even though there are still a lot of media which could be used in the learning process, both print and non-print media. As a result, students tend to be lazy and less interested in both receiving lessons and doing assignments and of course will affect students' ability to solve problems (Nursita et al., 2015). This is based on the results of the questionnaire which 53.57% of students stated that they still often found difficulty in understanding Physics material. This was also found by Parwati et al. (2018) that teachers have not found effective ways to teach problem solving so that this causes low student problem solving ability.

The test results of students' conceptual understanding of Newton's Law material shows that almost all students are still unable to describe the forces acting on an object. Moreover, if the material presented in the form of a story, most of students are not able to solve the problem. The results of the needs analysis show that students' conceptual understanding is very low. Even though, Newton's law concept is a basic concept that must be understood by students and has many applications in daily life (Sastradika & Jumadi, 2018). So, it is better to improve student reasoning and encourage deep understanding of concepts that must be applied in the classroom practice (Jensen et al., 2014). Thus students can build their own knowledge and actively participate in the learning process (Suryani et al, 2018).

To overcome this problem, it is necessary to improve the learning strategy by making worksheets which are appropriate to the needs of students. This worksheet is a learning cycle 7E based worksheet. The worksheet presented is arranged in sequences following the 7E learning cycle model, i.e. **elicit**, **engage**, **explore**, **explain**, **elaborate**, **extend**, and **evaluate**. According to Novitasari (2014), understanding students' concepts has been increased during the implementation of the learning cycle model. Understanding the concept of students who take part in learning with the learning cycle learning model is better than understanding the concepts of students through conventional learning. This is achieved because students are able to build their own knowledge and can work well together in groups during the learning process. Students are required to conduct experiments in a real way, not through simulation. It is because computer simulation does not positively influence the increase in understanding of concepts (Renken & Nunez, 2013). Students who demonstrate will be actively involved in learning so students are more enthusiastic in learning (Zhilin, 2014). This is in line with the research conducted by Imaniyah et al. (2015), that there is a positive effect of the Learning Cycle 7E on student learning outcomes in senior high school, where the average value of the experimental class using the Learning Cycle 7E is higher than the control class .

The purpose of this study was to apply learning using a student cycle based learning cycle 7e to analyze the increase in understanding of concepts and students' problem solving abilities in terms of practicality and effectiveness in the learning process of Newton's law. Based on these objectives, the formulation of the problem in this study, as follows:

1. How is the practicality of student worksheets on Newton's law-based learning cycle 7E?
2. How is the effectiveness of student worksheets on Newton's law-based learning cycle 7E?

METHOD

Pretest-postest with control group design was used in product trial (Sugiyono, 2015) and illustrated as in Table 1.

Table 1. Design was used in product trial

Class	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

Information:
X_1= Treatment of learning using student worksheets based learning cycle 7e
X_2= Treatment of learning using conventional student worksheets

Data on the results of assessment of the implementation and response of students was in the form of qualitative data, and test data on the students ability to understand the concept and problem solving in the form of quantitative data seen from the pretest and posttest scores of students.

The sampling technique used a purposive sampling technique, schools are chosen based on researchers' considerations regarding the quality and location of the school. Sample research to obtain data on needs analysis in schools, researchers involved 30 students and 3 high school teachers to fill out the questionnaire. The product trials in this study involved 40 of 10-grade senior high school students in Bandar Lampung district, of which 20 students were taught using 7E cycle learning cycle based student worksheets and as a comparison to conventional student worksheets applied to 20 students in the same school and grade level.

Research instrument

The research instrument used a questionnaire that was used to collect data on implementation & student responses. As well as 10 multiple choice questions to see students' conceptual understanding and 5 essay questions are used to see students' problem solving abilities. Before being used all researchs instruments have been tested for validity and reliability.

Data analysis

The practicality of student worksheets is determined by the implementation of the student worksheets and student responses to the student worksheets used. The questionnaire results are calculated by the average score then interpreting the average score percentage using the interpretation based on Arikunto (2016) in Table 2.

Table 2. Conversion Score Rating Value Statement Quality Practicality

Skor	Criteria
81% - 100%	Very Good

61% - 80%	Good
41% - 60%	Sufficient
21% - 40%	Insufficient
0% - 20%	Very Insufficient

The effectiveness of interactive electronic books as a source of learning Physics toward the students using analysis of average gain scores is then interpreted using classification of Meltzer (2002) as presented in Table 3.

Table 3. Criteria Interpretation of N-gain

Gain Value	Criteria Interpretation
$(g) > 0.70$	High
$0.30 < (g) \leq 0.70$	Medium
$(g) \leq 0.30$	Low

Data analysis was also supported by a t-test consisting of paired sample t test to determine the increase in the value of the pre-test with post-test in the experimental class and independent sample t test to determine the difference of post-test scores average in experimental and control class.

RESULTS and DISCUSSION

The practicality of learning cycle-based worksheet is measured through the implementation of worksheets in learning and student responses toward the worksheets. The implementation of student worksheets in learning consists of learning activities that refer to learning cycle 7e, social systems, reaction principles, support systems, and instructional and accompaniment impacts. The results of worksheet implementation observations can be seen in Table 4.

Table 4. Observations Feasibility of Student Worksheet Based Learning Cycle 7E

Meeting	Aspects Observation	Observer I	Observer II	Average	Average Every Meeting
I	Step activities	85	79	82	81
	System social	70	85	78	
	Principles of reaction	95	75	85	
	Support Systems	80	87	83	
	Impact of instructional	75	80	78	
II	Step activities	87	84	85	84
	System social	70	85	78	
	Principles of reaction	95	75	85	
	Support Systems	80	87	83	
	Impact of instructional	80	80	80	
III	Step activities	85	78	81	81
	System social	80	85	83	
	Principles of reaction	95	80	88	
	Support Systems	80	87	83	
	Impact of instructional	85	80	83	

Meeting	Aspects Observation	Observer I	Observer II	Average	Average Every Meeting
	Average	83			

Judging from several aspects of observation, the implementation of worksheet obtained an average score of 83% included in very high or very good category. It means that learning cycle 7e-based worksheets used have steps in activities, social systems, reaction principles, support systems, and excellent instructional impacts. This is in line with the research conducted by Balta & Sarac (2016) that learning cycle 7e has a positive effect on student achievement outcomes. In addition, the results of student responses to learning cycle 7e based worksheet can be seen in Table 5.

Table 5. The results of the Student Response Student Worksheet Based Learning Cycle 7E

No.	Respose	Persentase
1.	Positive	83%
2.	Negative	17%

Table 5 shows the results of students' response to 7e learning cycle based student worksheets used in learning received a positive response (83%).

The next is analyzing the understanding of concepts and problem solving of students. Determining the level of conceptual understanding of students can be considered as the first step that aims to involve students in the learning process, because understanding concepts includes association, comparison, assimilation, and reorganization of new knowledge with existing knowledge and transferring it to solve new problems (Saricayir et al., 2016). Based on the results of the analysis of understanding the concepts and problem solving abilities of students in the experimental class and control class can be seen in Table 6.

Table 6. Results N-gain and different test Students' Conceptual Understanding and Problem Solving

Aspect	Class	*Pretest*	*Posttest*	*N-gain*	Criteria	*P-Value*
Concept Understanding	Experiment	39,79	79,27	0,66	Medium	0,000*
	Control	29,32	72,25	0,55	Medium	
Problem Solving Ability	Experiment	37,81	71,77	0,64	Medium	0,000*
	Control	17,83	40,50	0,28	Low	

Based on Table 6, it can be figured that the worksheet results of the development are effective to improve students' conceptual understanding and students' problem solving abilities. The results of the analysis of the independent sample t-test, there were significant differences in significance ($p < 0.05$) between the experimental class and the control class. The results of the concept understanding tests of students in the experimental class and the control class for each indicator can be seen in Table 7.

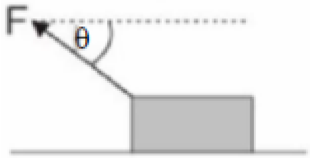
Table 7. Result of Pretest, Posttest, and N-gain Conceptual Understanding Indicators

Indicator	**Experiment**			**Control**		
	Pretest	***Posttest***	***N-gain***	***Pretest***	***Posttest***	***N-gain***
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Interpreting	37,50	83,13	0,73	35,00	70,00	0,54
Explaining	38,13	81,25	0,70	36,25	67,75	0,49
Classifying	41,25	81,25	0,68	37,50	78,75	0,66
Exemplifying	41,25	78,75	0,64	38,75	68,75	0,49
Comparing	40,63	72,50	0,54	39,38	68,13	0,47
Concluding	40,00	78,75	0,65	40,00	77,50	0,63
Average	39,79	79,27	0,66	37,81	71,81	0,55

Table 7 shows the comparison of the values of pretest, posttest, and N-gain understanding of the concepts outlined in each aspect of understanding (interpreting, explaining, exemplifying, classifying, comparing and concluding) between the experimental class and the control class. The ability to interpret has the highest posttest score (83.13) in the experimental class. Interpreting can be done by changing information from one form to another, such as changing verbal into other verbal, changing images into verbal and vice versa, symbols become verbal and vice versa. This ability is obtained by students because students have been trained with phases found in learning cycle 7e based student worksheets because understanding interpretation can develop when students make interpretations of the information obtained and when explaining the meaning of a statement (Widiadnyana, 2014). Understanding the interpretation becomes very important because due to the misinterpretation of the symptoms or events encountered, misconceptions can occur. Students determine the concept of what enters the brain, interprets and stores it. Students who passively cause the rearrangement of knowledge in their brains will not occur, on the contrary the more active students are involved in the learning process, the better the understanding of the concept (Murni, 2013).

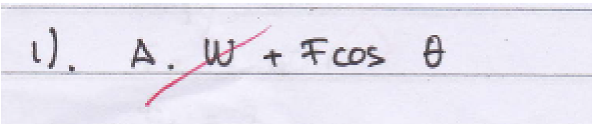
Understanding students' concepts can be seen from the answers to student tests, in Figure 1 and 2 there are examples of student questions and answers.

1. Balok yang beratnya w ditarik sepanjang per-mukaan mendatar dengan kelajuan konstan v oleh gaya F yang bekerja pada sudut θ terhadap horizontal. Besarnya gaya normal yang bekerja pada balok oleh permukaan adalah ....

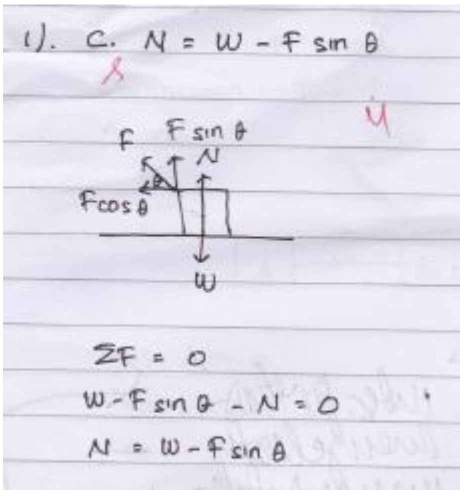


A. $W + F\cos\theta$
B. $W + F\sin\theta$
C. $W - F\sin\theta$
D. $W - F\cos\theta$
E. W

Figure 1: Questions to improve understanding of concepts



(a) *Pretest*



(b) *Posttest*

Figure 2: Student answers to concept understanding tests

Based on the results of student answers (Figure 2), students only answer, not accompanied by the reason for choosing the answer. However, after learning with a physics LKS based on learning cycle 7E, the students' answers become complete with a description.

While the lowest ability (73.75) for indicators compares in the experimental class. This is because the indicator comparing requires the ability to detect the relationship between two ideas or concepts; students are not accustomed to finding relationships between two things or two concepts. Thus students need to be given more opportunities to develop the ability to compare in the learning process (Dewi, 2012).

Based on research by Susilawati et al., (2014) that improving concept understanding, the 7E learning cycle learning model contributes better results compared with the direct learning model. Pratiwi (2014) states that the characteristics of learning activities at each stage of the learning cycle reflect learning experiences that interact directly with the environment in constructing and developing understanding of concepts in accordance with curriculum development in Indonesia. So students are directly involved in scientific investigation, decision-making and real-life problem solving (Sunarti et al, 2018).This is supported by the study of Duran et al. (2011) that learning cycle 7E is a method that can help students explore scientific concepts and help teachers when planning lessons related to an in-depth understanding of the concepts being taught. The results of the students' problem solving ability tests in the experimental class and the control class for each indicator can be seen in Table 8.

Table 8. Result of Pretest, Posttest, and N-gain the problem solving indicators

Indicator	**Experiment**			**Control**		
	Pretest	***Posttest***	***N-gain***	***Pretest***	***Posttest***	***N-gain***
Showing the model	51,50	84,75	0,69	40,25	62,25	0,37
Make the analysis	20,00	69,75	0,62	13,25	31,50	0,21
Validating	0,00	62,25	0,62	0,00	27,75	0,28
Average	23,83	72,25	0,64	17,83	40,50	0,29

Based on Table 8, the problem solving indicators of students in the experimental class obtained the highest posttest score (84.75). Other indicator showing the model and the N-gain scored 0.69 or medium category, as well as other indicators in the experimental class the value of N- gain is also categorized as medium. Indicators showing the model and make the analysis fall into the medium category because it is supported by good student interpretation skills. This is in line with the statement of Haryani (2011) that at the stage of understanding the problem so that students can understand the problem he must have the ability to interpret so that he understands precisely the problems posed to him. In addition, he must also have the evaluation ability to evaluate his thinking in understanding the problem. Solving students' problems can be seen from the answers to student tests, in Figure 3 and 4 there are examples of student questions and answers.

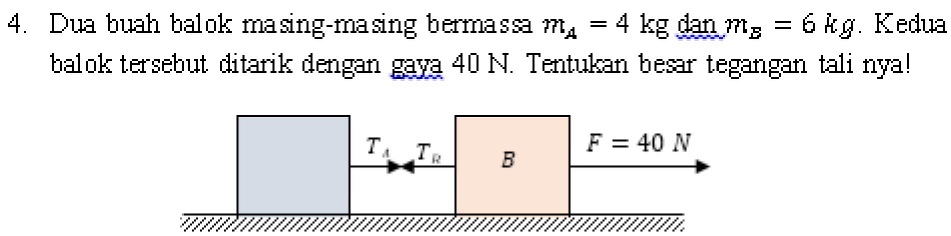
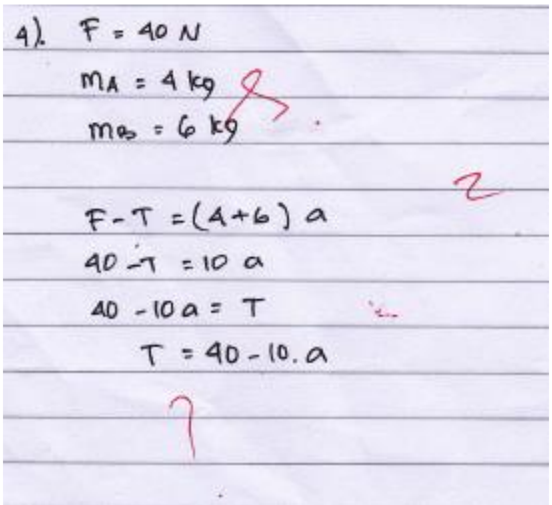
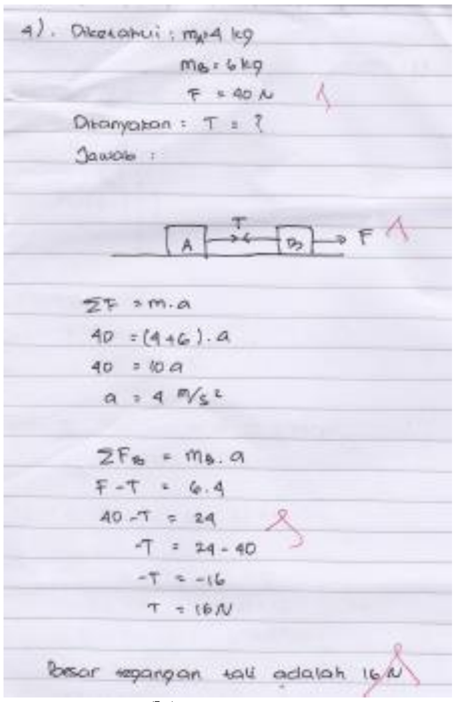


Figure 3: Problem solving test questions



(a) *Pretest*



(b) *Posttest*

Figure 4: Student answers to problem solving tests

Based on the results of student answers (Figure 4), students only answer, not accompanied by a description of the answer. However, after learning with a physics based on learning cycle 7E worksheet, the students' answers become complete with a description of the answers starting from displaying the model, making analysis, and validating.

Overall learning by using worksheet based on learning cycle improves students' problem solving abilities in terms of indicators showing models, making analysis, and validating. The N-gain value in the control class is included in the medium category (0.37) for indicators displaying the model and for analyzing indicators (0.21) and validating indicators (0.28) included in the low category. It means that worksheet is used effectively in learning activities. In this case the worksheet acted as a hard scaffolding that could help students interacted actively in learning and encouraged students at the level of competence in the ability to solve physical problems that were in accordance with the learning objectives (Nurulsari et al., 2017).

A teacher must pay attention to the effectiveness in teaching and learning activities carried out, including learning feedback (Abdurrahman et al, 2018). It is because the effectiveness determines the success of the learning process in achieving the indicators that have been formulated. Based on the results of the study there was a significant increase before and after using worksheet based on learning cycle 7E. This indicates that worksheet based on 7E learning cycle is effective to be used to improve concept understanding and problem solving abilities in tenth grade senior high school students in Bandar Lampung district. This is also in accordance with Ajaja's statement (2013) in his research saying that students who learn using the learning cycle have higher learning outcomes. This is because learning cycles are learning concepts about how people learn from experience (Adesoji & Idika, 2015). The learning cycle ensures that students are active in the classroom, they have the opportunity to research and analyze, and help students independently to connect concepts, details, models, and applications to the material they are studying (Jack, 2017). So that understanding concepts and problem solving abilities can be enhanced.

CONCLUSION

The results of this study indicate that student worksheets based on the 7E Learning Cycle with regard to Newton's Law of motion are practical and effective to enhance students' conceptual understanding and physics problem-solving abilities. Practically, it can be seen from the results of the implementation of student worksheets in students 'learning and positive responses as well as effective both in improving students' understanding of concepts and in solving physics problems. This research has thrown up many opportunities in need of further investigation. Further research needs to be done to establish whether the 7E Learning Cycle appropriate implemented in various levels of education and the countries.

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