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MERRY GO ROUND TECHNIQUE AND STUDENTS' PHYSICS COGNITIVE LEARNING OUTCOMES ON WORK AND ENERGY TOPIC

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ABSTRACT

This study aims to determine the difference in learning outcomes in work and energy from students who learned using inquiry training model with merry-go-round techniques. This study was designed using a quasi-experimental design with 74 students as samples. The instrument developed was 21 questions about work and energy. The results show that the experimental class has the highest value of 85.27 compared to the control class with 77.56. The test results of the physics learning outcomes hypothesis were t_{count} (3,295) >t_{table} (1,666), indicating that there were differences in physics learning outcomes of students who studied using the inquiry training model with the merry-go-round technique than students who studied conventionally.

Keywords: inquiry training; merry-go-round; cognitive learning outcomes

INTRODUCTION

The current education is still improving itself with more human learning patterns. There are several problems in the education world in Indonesia, including the low quality of graduates and the absorptive capacity of graduates in the work world. Therefore, the government tries to innovate in reviewing and updating the existing curriculum consistently. One of the things that can be improved is the high school graduates competency standards, which are expected to have dimensions of factual, conceptual, procedural, and metacognitive for science, technology, arts, culture, and humanities (Medina et al., 2017). The current curriculum used by the Indonesian state is the 2013 Curriculum which emphasizes the scientific approach. The scientific approach is designed for emerging the students' talents and interests well and facilitate students in learning activities by constructing the concepts, laws, and principles of a learning material (Bigozzi et al., 2018; Tambunan, 2019). Experimental or research-based learning models strengthen the scientific approach that is carried out in the learning process. Therefore, current learning in Indonesia must follow the existing rhythm.

One learning model that can facilitate students' quality of student knowledge is inquiry (Wartono et al., 2017). Inquiry is a process of scientific inquiry carried out to find answers (van Uum et al., 2016; Lamsa et al., 2018; Naezak et al., 2021). Inquiry means students are involved in

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asking questions, seeking information, to making conclusions (Helmreich & Krog, 2018). The inquiry learning model emphasizes that students think high-level and analytical to find their definitive answers to a questioned problem through an investigation (Hong et al., 2019). Inquiry provides more opportunities for students to ask many questions that lead to scientific discoveries to build new concepts and knowledge (Arsal, 2017).

One of the things that cause students' low physics learning outcomes is inappropriate learning models (Cooper, 2018; Le et al., 2018). Another thing that indicates students' low cognitive learning outcomes are a lack of concept understanding (Karagiannopoulou & Entwistle, 2019). Inquiry learning emphasizes active learning and is expected not to be teacher-centered. Students obtain knowledge in the form of material based on experience (Saunders-Stewart et al., 2012). In addition, the inquiry model provides more experience directly and interacts in the learning process.

Inquiry learning has a relationship with the Merry-Go-Round (MGR) cooperative type. Students can experiment to improve creativity. Learning is active in contributing ideas in their groups to improve the quality of learning in the classroom. Recently, inquiry research and merry-go-round learning on work and energy are still limited. Inquiry accompanied by the merry-go-round technique also allows students to develop higher-order thinking skills involving existing scientific work problems. The MGR technique has characteristics where group members can contribute and listen to thoughts or ideas from other members (Oakes et al., 2019). Some of the advantages of merry-go-round techniques are increasing positive learning activities, efficiency in time, increasing critical thinking and creativity to answer problems, fostering patience (Ahmadi & Besançon, 2017). The merry-go-round technique can develop students' patience to wait their turn to ask questions. In the merry-go-round technique, learning activities are oriented to the inquiry training learning model. So the focus of this paper tells on collaborating MGR and inquiry training learning model in improving students' learning outcomes in physics.

The inquiry training model can provide experience in conducting experiments for students. Meanwhile, MGR techniques can help students remember the learning and communicate new ideas or findings from other groups. So the use of MGR techniques in learning models can help teachers in the learning. In addition, improving memory, communication skills, and understanding of the material in students can be improved by using an inquiry training learning model with the technique of MGR. If learning is successful, difficulties in learning physics become things that need to be considered to succeed in learning (Haidar et al., 2020). It is expected that learning outcomes will also increase and can support conceptual understanding as fundamental in physics education (Bao & Koenig, 2019). Learning outcomes are the success that someone has achieved after carrying out the learning process activities so that there is a behavior change (De Hei et al., 2018), and learning outcomes can represent what a student understands (Lestari et al., 2019).

As for some physics topics that are still considered difficult such as mechanics, thermodynamics (Bezen et al., 2016), work and energy (Kurnaz, 2014; Büyükdede & Tanel, 2019), quantum mechanics (Krijtenburg-Lewerissa et al., 2017), training inquiry learning models have suitability in the learning process on the topic of work and energy. At the confrontation stage, the teacher gives examples of applications or phenomena in everyday life. By providing real phenomena occurring in their lives, students will look for reasons why it happened. Then students make the temporary reasons become hypotheses in implementing the experiment that will be carried out next. Inquiry training learning models can provide direct experience in the learning process. In contrast, merry-go-round techniques allow students to communicate their new findings or ideas to other groups and improve their memory of the material being studied. This research aims to determine differences in learning outcomes on work and energy from students who learned using inquiry training learning models with merry-go-round techniques.

METHODS

The research was conducted using quasi-experimental research. After knowing the results, the experimental class was given learning using an inquiry training model with merry-go-round techniques and control classes given conventional learning models. The steps of learning carried out in the both classes are shown in Table 1.

Table 1. Step in Both Classes

	Control Class	Experimental Class
First step	Problem confrontation	Problem confrontation
Second step	Verification	Verification
Third step	Practicum	Practicum
Fourth step	Discussion	Elaboration + MGR
Fifth step	Evaluation	Evaluation + Apply New Concept

After both classes have carried out teaching and learning activities, the two classes are given a posttest to find out the learning outcomes. The study was conducted for five months, from data collection to analysis.

Table 2. Pretest/Posttest Control Group Design

Experimental class	O_1	X	O_2
Control class	O_3		O_4

The sample of this research was all tenth-grade science students of SMA Negeri 1 in Batu-Malang city, consisting of 6 classes (74 students). The sample in this research was taken using the random sampling technique. The selected sample was students from tenth-grade science-5 students as the experimental class received treatment using an inquiry training learning model with the merry-go-round technique. Students from tenth-grade science-2 were selected as the control class, which is treated in the conventional learning model. The number of samples was 74 people, 37 in the experimental class and 37 in the control class. Students' academic abilities are at a moderate level. The location of the school is in a mountainous area with relatively cold temperatures.

The test instruments of physics learning outcomes consist of 30 multiple-choice questions. Before the two instruments were used, validation was done by the lecturer validator. Then, empirical validation was done on students who had learned about work and energy. The results of empirical validation obtained 21 valid items from 30 items. After testing for normality and reliability, levels of difficulty and power are tested. Based on the difficulty level test, two items were difficult, three items were moderate, and 16 items were easy. Meanwhile, for the different tests, it was obtained two items with bad criteria, eight questions with sufficient criteria, and 11 questions with good criteria. Test questions consist of questions about physics concepts about work and energy. Question categories are the level of analysis developed in physics students at the University of Colorado. The test instrument for this study was a multiple-choice question. Before the research was conducted, the field trial was necessary to measure validity, reliability, level of difficulty, and differentiation of items about instruments of learning outcomes physics. After the test items were tested, standardization of instruments was carried out, testing empirical validity, reliability, difficulty, and differentiation tests.

The 21 valid items were used for making pretest and posttest questions. Then, the items proceeded to calculate the value of reliability to know the instrument's stability. The reliability test results of valid items were 0.788, so that can be concluded that the question instrument has a high-reliability value (Brookhart & Nitko, 2019). From 21 valid items, only 20 valid questions were used in conducting research. The data obtained from the research were pretest values that showed the students' initial ability and posttest scores which showed students' physics learning outcomes. Then, the analysis was done using the analysis prerequisite test consisting of normality test and homogeneity test with a significance level of 5%. Hypothesis testing using a T-test to determine whether there were differences in the achievement of the experimental and the control class.

RESULTS AND DISCUSSION

The results of students' physics learning outcomes were shown on the pretest and posttest results that had been analyzed quantitatively. The difference from the acquisition of physics learning outcomes from the two classes with different treatments were then compared and discussed in theory and the actual results. The following is an explanation of the results of the research that had been obtained. The pretest was used to find out the initial abilities of both research classes. The acquisition of pretest data from both classes was then analyzed. The results of the pretest data analysis are shown in Table 3.

Table 3. The Pre-Test Results Data of Different Class

Class	The Number of Students	The Lowest Value	The Highest Value	Average	Standard Deviation
Experimental	37	30	80	46.62	15.09
Control	37	30	75	45.81	13.36

The low pretest mean scores in both classes resulted from a lack of learning related to work and energy materials. In addition, the results obtained show that the learning that has been done so far has not been fully implemented. As a result, there was no intensive guidance through learning conducted by the teacher; finally, some students stare to find value without knowing the basic concepts that exist. In addition, the learning pattern carried out by students makes them cannot fully understand the whole material that will be taught or is being taught. Thus, the students had lack knowledge of the material being tested. Therefore, efforts to improve student learning outcomes can be made using learning methods that make students active to understand that information about the material. Moreover, after the two classes were treated according to the study design, the two classes got posttests to determine the students' physics learning outcomes and the influence of the treatment given to each class. The results of the posttest data analysis are shown in Table 4.

Table 4. The Post-Test Results Data of Different Class

Class	The Number of Students	The Lowest Value	The Highest Value	Average	Standard Deviation
Experiment	37	55	95	85.27	8.893
Control	37	50	100	77.56	11.09

The data obtained is then analyzed using the prerequisites analysis, namely the normality test and homogeneity test. After conducting the prerequisite analysis test then a hypothesis test is carried out to determine student achievement in the different classes, as shown in Table 5.

Table 5. Prerequisite Analysis Results of Hypothesis Analysis

Test Aspect		Calculate Value	Table Value	Level of Significance	Category
Normality (Liliefors)	Experiment	0.136	0.145	5%	Normal
	Control	0.115	0.145	5%	Normal
Homogenity (Fisher)		1.55	1.74	5%	Homogenous

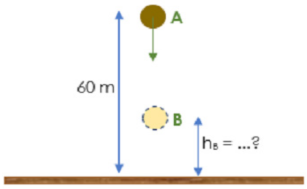
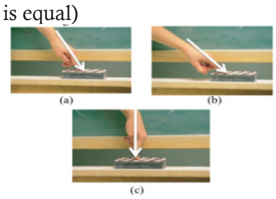
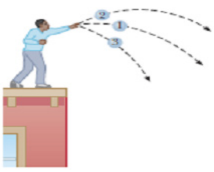
Research hypothesis testing is carried out after the prerequisite test, consisting of normality test and homogeneity test in the different class on the posttest value. The normality test and homogeneity test results on the students' posttest scores indicate that the data obtained is normally distributed and homogeneous. The research hypothesis test used is the T-test, as shown in Table 6.

Table 6. Hypothesis Test

Class	N	–	Level of Significance	t_{count}	t_{tabe}
Experimental Class	37	85,27	5%	3.295	1.666
Control Class	37	77,56	5%		

The analysis results showed that tcount>ttable = 3.295> 1.666. Thus H0 was rejected and Ha received. So it can be concluded that the experimental class students' physics learning outcomes using inquiry training learning model with more techniques MGR is higher than control class. The difference from the mean value indicates the influence of the learning process carried out in the different classes. Combined with the merry-go-round technique, the inquiry training model provides experience directly from the implementation of the experiment. While the merry-go-round technique provides opportunities for students to share new knowledge. Students are trained to have the ability to convey ideas or opinions to other groups. Furthermore, from the existing process data, the students' answers show that students can give good answers to merry-go-round techniques, as shown in Table 7.

Table 7. Student Answers of Work and Energy Questions

Questions	Answers	Cognitive Aspect
A ball with a mass of 2 kg falls freely from position A as shown.  When it reaches B, the kinetic energy is two times its potential energy. Calculate the height of point B from the ground surface! a. 15 m b. 20 m c. 45 m d. 60 m e. 80 m	By using law mechanical energy conservation, then $EM_A = EM_B$ $Ep_A + Ek_A = Ep_B + Ek_B$ $Ep_A + Ek_A = Ep_B + 2Ep_B$ $Ep_A + Ek_A = 3Ep_B$ $mgh_A + \frac{1}{2} mv_A^2 = 3mgh_B$ $gh_A + \frac{1}{2} mv_A^2 = 3gh_B$ $(10)(60) + 0 = (3)(10) h_B$ $600 = 30 h_B$ $30h_B = 600$ $h_B = \frac{600}{30} = 20$ m	C3
If we push the eraser in a way like (a), (b), and (c), which is the most effective way for the eraser can be easily moved successively? (assume the given work is equal)  a. (a) ; (b) ; (c) b. (b) ; (a) ; (c) c. (c) ; (b) ; (a) d. (c) ; (a) ; (b) e. (b) ; (c) ; (a)	The most significant effort occurs when the angle formed between the work F and the plane when it meets $W = F.\cos\theta . s$ The value of $\theta = 0$ or angle has the same direction to the work given, which will produce the most significant effort. When the value $\theta = 0$, it is the most effective way to move the eraser. So the most effective way to move the eraser is (b) ; (a) ; (c)	C4
Three identical objects are thrown from the top of a building with the same initial speed, as in the following figure.  The first object is thrown horizontally, the second object is thrown by forming an angle above the horizontal, and the third is thrown by forming an angled bottom the horizontal. Then, the speed of the three objects when touching the ground is ... a. v_3 is faster than v_1 and v_2 b. v_1 is faster than v_2 and v_3 c. v_2 is faster than v_1 and v_3 d. v_3 and v_2 faster v_1 e. $v_1 = v_2 = v_3$	The three balls thrown have the same kinetic energy as the system ball-Earth. All three balls also have the same change in a review of gravitational potential energy. So that according to the law of conservation mechanical energy: Ema = Emb, then all three balls will also have the same speed when touching the ground.v1= v2 = v3	C4

Learning with the inquiry training model with the merry-go-round technique shows that student learning outcomes and students' understanding of concepts increase through this learning model. Examples can be taken, such as the work on students' pretest and posttest questions. When working on pretest questions, almost all students answered questions number 11, 12, 13 incorrectly because students did not understand the relationship between work and kinetic energy. Example problem number 12:"Reza went to school on a wooden bicycle. He pedaled his bicycle with a work of F and made work as big as W. When Reza saw a truck crossing the road that was a distance s from his position, Reza had to reduce the speed to ½ v. Then what Reza had to do so that the speed of the bike decreases to ½ v?"

In the above problem, almost all students answered that to reduce the bike's speed to ½, and the given work must also reduce ½ of the initial work. Students did not understand the concept of kinetic energy relations. The relationship with kinetic energy states that total effort on a moving object is equal to its kinetic energy. The results of students' answers are not entirely correct. This is due to students not yet accustomed to developing knowledge in the inquiry process.

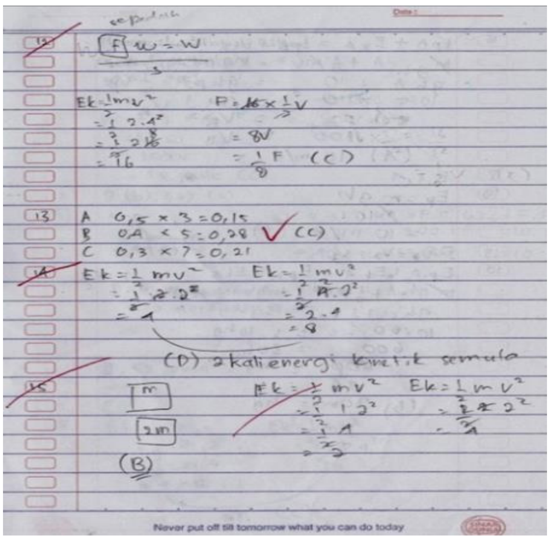


Figure 1. Results of Students' Pretest

However, after receiving treatment in applying inquiry training learning models with the merry-go-round technique, most students have answered correctly. Some students gave reasons and complete explanations on their answer sheets, as in Figure 2.

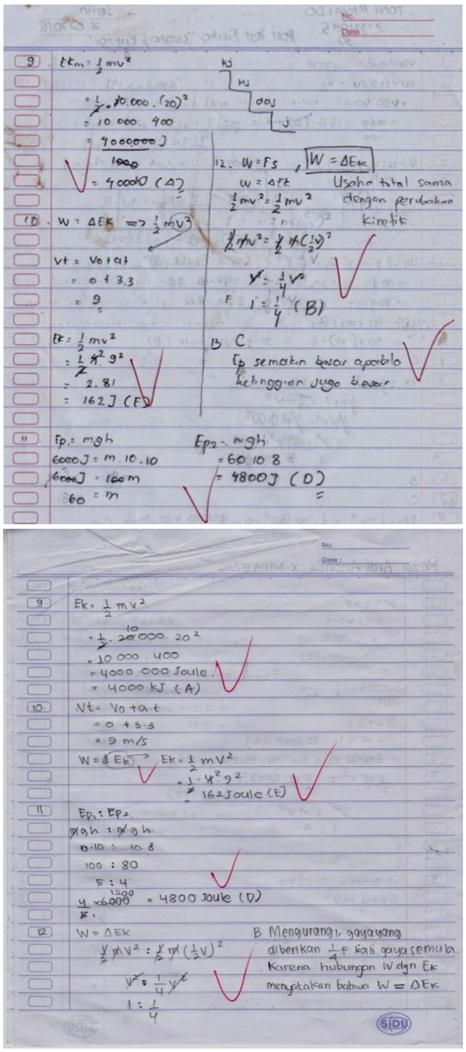


Figure 2. Results of Students' Answers to Post-Test Activities

The use of inquiry training learning models with merry-go-round techniques can help students remember the learning process of the material learned, primarily through the phenomena shown initially, which can stimulate students' thinking. Figure 2 shows the student answer sheets that answer correctly on problem number 12. The inquiry-based learning through inquiry training models given to students in the experimental make them more active and develop their abilities to make learning more meaningful (Cruz-Guzman et al., 2018). Meaningful learning can occur when students can connect between real experiences, previous knowledge, and discoveries and finally be able to apply them (Agra et al., 2019). By involving cognitive, it can trigger attention and willingness to exert effort in order to be able to understand a concept to improve learning outcomes better (Chi & Wylie, 2014). Inquiry training learning model increases learning motivation and understanding of students' physics concepts. Moreover, mastery of experimental class physics concepts taught with inquiry training models is also higher than control classes taught with conventional learning models (Batong & Wilujeng, 2018; Pandya, 2018). In addition, the application of inquiry training learning models is proven to improve student learning outcomes (Yakar & Baykara, 2014).

An inquiry training learning model with an MGR technique can train students to be responsible for themselves and the group. Each student will get the same burden because, at the time of discussion, each student must convey their new ideas or findings in an experiment that will properly activate the course of the discussion. This study illustrates that the use of inquiry training learning models with merry-go-round techniques can provide an excellent contribution to the implementation of learning activities in schools, especially towards improving students' physics learning outcomes.

These findings support the opinion that the MGR technique is a type of learning that accustoms students to work according to democratic notions and provides opportunities for students to develop a deliberative and responsible attitude and respect the opinions of others. The procedure provides sufficient time to construct knowledge effectively and meaningfully. The inquiry training learning model with the merry-go-round technique has many advantages over the usual learning methods in the classroom. The use of inquiry training learning models with MGR techniques provides many benefits for students. It can be seen from the learning outcomes of the students of senior high school 1 in Batu city who studied with the inquiry training learning model with merry-go-round technique higher than students who learn to use the usual learning methods in the classroom.

Students who have understood the material through the inquiry process will be able to solve physics problems. The inquiry-based learning through inquiry training models given to students in the experimental class makes them more active and develops their abilities to make learning more meaningful (Smit et al., 2017). Education can occur when students can connect between real experiences, previous knowledge, and discoveries and finally apply them (Owens & Tanner, 2017). Inquiry-based learning through the inquiry training model also emphasizes how students learn with cognitive processes to achieve scientific concepts and skills (Caswell & LaBrie, 2017; Darling-hammond et al., 2019). By involving cognitive, it can trigger attention and willingness to understand a concept to improve learning outcomes.

CONCLUSION

Based on the research results, it can be concluded that there are differences in physics learning outcomes for the work and energy on students taught using inquiry training learning models with merry-go-round techniques and students taught using conventional learning models. The implication of this study is to provide information for learners to reconstruct learning centered on communicating new findings or ideas to others and improving their memory in the material being studied. The limitation of this study was in its exploration that only explores student activities at pretest and posttest, so it is expected that the subsequent study can take more attention in improving the merry-go-round technique at each meeting and every topic to have better learning.

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