The ICARE Practice Based on Worksheet and Physics Experimental to Improve Student Creativity

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Abstract. Creativity is one of the important elements in learning physics but is rarely studied to find out the effects of teaching applied to increasing creativity. The research is intended to describe the use of The ICARE Practice Based on Worksheet in increasing student creativity in the Physics Education Study Program. The course assessment formally uses The ICARE Practice Based on Worksheet and the Independent Torrance Test for creativity. At the beginning of the lesson given an explanation of work instructions followed by group organizing. The group used The ICARE Practice Based on Worksheet to conduct physics experiments with the guidance of lecturers. The experimental results of each group were presented by each group and continued with interactive debates between presenters and comparison groups. Input provided by lecturers and students is used to make reports individually. The Independent Torrance Test is given as a pretest and posttest. Increased creativity is an effect of applying The ICARE Practice Based on Worksheet in experimentation. The gain is based test results were obtained from the posttest and pretest ratings. The test results show that improvement through creativity indicators is achieved on Originality, Flexibility, and Elaboration. The indicator has an increase of more than 70 % of the number of students with N-Gain score is 0.38 in the medium category.

Keywords: ICARE; Worksheet; Creativity; Physics Experimental

1. Introduction

Experimentation is one of the student activities that is needed by students in learning physics [1]. Through experimental activities students will research opportunities that can encourage them to think scientifically and rationally and further their experiences can develop in the future [2].

The term experimental activity is also called the experimental method. The experimental method is an effective method because it gives a concrete picture and direct experience to students so that during the process of experimental activities students believe in the truth of their own conclusions. Likewise, the scientific attitude of students in experimental activities, as an inseparable part [3].

Based on the survey results, several studies show that the implementation of experiments in schools, especially Indonesia, is still lacking. This is because in addition to the teacher's limited knowledge in designing and applying the experimental method, it is also because the experimental method requires a longer time allocation, exceeding the time allocation available in the school's school curriculum [4], [5].

Understanding and experience of students can be formed, depending on what is learned and how they learn it. Through experimental activities, students are expected to be able to master more deeply (‘appreciate') various concepts, and advanced physics principles, and be able to develop creativity in
designing experiments [3]. In physics experimentation activities, students can develop skills such as observing, measure, communicate, conduct experiments, process data and deduce gradually based on the characteristics of teaching material. Effective implementation of experiments requires worksheets. The existence of worksheets will make it easier for students to add information about concepts learned through systematic and structured learning activities [6]. The worksheets that are arranged make it easier for educators to carry out learning, while students will learn independently, understand and carry out written assignments [7].

The preparation of student worksheets also requires a structured implementation mechanism in accordance with specified competencies. The structure used in preparing students' worksheets is developed from the ICARE concept (introduction, connect, apply, reflect, extend). ICARE learning emphasizes the characteristics of: active, creative, and fun (joyful learning) [8], in this study it is called the ICARE practice based on worksheets for conduct physics experiments.

The Introduction activity contains an explanation of the objectives and competencies that students will achieve after the learning activities are correlated; Connecting activities include the activities of students in a way to induce students to be needed to achieve learning objectives related to facts, concepts, principles/laws, theories, and physics procedures. In this study the main learning source is textbooks for high school physics courses accompanied by ICARE practice is based on worksheets for conduct physics experiments, another relevant source on sites on the internet network. Learning resources that are connected with students refer to the concept of active learning as well as fun, for example, showing videos, animations and other media; In Applying activities, students conduct experimental activities to prove the truth of the concepts obtained from the connecting phase. In Reflecting activities, students provide an explanation of the extent to which achievements have or have not been obtained or understood by students related to proof of concept through experimental activities; Extending activities, students can design experimental activities through simple using the same principles to understand the concepts that have been obtained.

Through the learning stages of the ICARE concept, the applying phase is designed so that students carry out experimental activities in proving the concepts that can be obtained. With the existence of experimental activities, it is expected that students can better understand teaching material because they can explore, prove, or test the real truth about a concept being learned [9]. The experimental method carried out can improve student creativity in carrying out experiments. This is because students are required to think creatively in the process of each step of the experimental activities [10]-[12].

Creativity is the ability to think about new and unusual ways and come up with unique solutions [13]. Creativity is an ability to see a variety of possible solutions to an increasingly complex problem where the individual must be able to think, form new ways or change old ways creatively in order to survive in increasingly fierce competition. Creative self-busyness is not only beneficial to the person and the environment, but also gives satisfaction to the individual. In addition, creativity also allows humans to improve their quality of life. In this era of development, the prosperity and glory of society and the state depends on creative contributions, in the form of new ideas, new inventions, and new technologies. To achieve this, creative attitudes, thoughts, and behaviours must be nurtured early on [14].

Very high creativity accompanied by great curiosity and thirst for the challenge of thinking makes someone fond of exploring. Creativity is a talent that is potentially possessed by everyone that can be identified and fostered through proper education, one of the critical problems is how to discover the creative potential of students and how to develop it through educational experience [14].

Creative abilities can be raised through problems that refer to indicators, namely: Fluency, Flexibility, Originality, and Elaboration [15]. The use of experimental and demonstration learning methods can help students learn directly. Apart from practical activities students can better understand the material presented, because students can experience the process of each activity step during the practice takes place. Where between the experimental and demonstration methods have a relationship that can improve learning outcomes in terms of the creativity of students [16].
2. Methods
This type of research is a quasi-experimental study. The study was conducted at the Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan. The research design used was one group pretest and posttest design [17]. The research sample is physics students who take high school physics courses. Before the treatment is carried out a pretest is conducted to determine the student's initial creativity. Then given treatment that students are guided and directed the ICARE practice based on worksheets for conduct physics experiments. After the treatment is done, posttest is done to find out the final ability of creativity possessed by students after conducting experimental activities using the ICARE practice based on worksheets for conduct physics experiments. This research is an advanced research and development (R&D) in the third year. Where high school Physics textbooks accompanied by The ICARE Practice Based on Worksheets for conduct physics experiments have been validated by media experts and material experts. The results of the validation carried out obtained that the worksheets of students are suitable for use in learning physics in high school physics courses. This research was conducted in several stages. At the beginning of the research implementation, students were given a pretest and then the students were given the ICARE practice based on worksheets for conduct physics experiments to train and develop students' creative abilities in carrying out high school physics experiments. After that students are given a posttest to find out the level of achievement of students' creative abilities after using the ICARE practice based on worksheets for conduct physics experiments to conduct high school physics experiments.

The mechanism of implementing high school physics experiments carried out by students is to follow the stages of ICARE (introduction, connecting, applying, reflecting, extending). The implementation of physics experiments by students is carried out in the applying phase. The mechanism of conducting experiments conducted by students through the ICARE practice based on worksheets for conduct physics experiments are: formulating the objectives of the experiment, formulating questions, formulating hypotheses about the experiments to be proven. The hypothesis formulation can be written by students in the section provided on the ICARE practice based on worksheets for conduct physics experiments, preparing tools and materials to be used in experimental activities. One topic of experimental activity in this research activity is analysis the dynamics of forces in the incline. Some tools and materials used in this experiment include: dynamometer, inclined plane, pulley, load and protractor. The stages of the experiment are: 1. Arranging tools and materials that have been prepared. The following is an experimental sample of a series of tools for conducting experiments on the dynamics of forces; 2. Carry out observations and measure the variables specified in the experiment such as the magnitude of the force, angle, and mass of the object; 3. Analyzing data about the measurement results of each measured variable, making graphs, interpreting graphs and comparing with the study of theories that support to prove hypotheses; 4. Based on the results of the discussion, the final stage is to conclude the results of the experiment.

![Figure 1. Arrangement of high school physics experiment equipment on Dynamics of Force.](image_url)

The research instrument used was the Independent Torrance Test given as a pretest and posttest. The data analysis technique is using the normalized N-gain equation to find out the increase in students'
creative abilities. Hake's explanation that to determine the normalized N-gain the following equation can be used: the following equation is used [18]:

\[
<g> = \frac{<S_{post}> - <S_{pre}>}{100 - <S_{pre}>}
\]

Then to determine the level of creativity achievement of N-gain students are converted as in table 1 below.

| Score N-Gain | Interpretation |
|--------------|----------------|
| N-Gain ≥ 0.70 | High           |
| 0.30 < N-Gain < 0.70 | Middle |
| N-Gain ≤ 0.30 | Low            |

3. Result and Discussion
The data obtained are the results of the Independent Torrance Test given as a pretest and posttest to students. The creativity value of students before and after using the ICARE practice based on worksheets for conduct physics experiments is as shown in Figure 1 below.

![Figure 2. Diagram of average scores of initial tests, final tests, and normalized Gain scores on a creativity test.](image)

From Figure 2 above shows that there is an increase in student creativity after doing the ICARE practice based on the spreadsheet to conduct physics experiments. This increase was shown by N-Gain by 38% with the medium category. The findings of this study are consistent with [19] research findings showing that the implementation of the ICARE approach can improve students' creative thinking skills with N-Gain 52% in the medium category [19]. The stages of student worksheet activities that were made systematically to be followed by students when conducting experiments could improve students' creative abilities [16]. Further analysis relating to the value of increasing each indicator of creativity is shown in Figure 3.

From Figure 3 shows that through the application of the ICARE practice based on worksheet to conduct physics experiments illustrate that there is an increase in each indicator of creativity shown by N-Gain namely the indicator of flexibility is 0.32 with the medium category, the fluency indicator is 0.24 less category, the originality indicator is 0.50 with the medium category, and for the elaboration indicator is 0.39 with the medium category.
According to students' confession when asked about their experience in making practical reports, their answers illustrate that they rarely did physics practices during their high school years. The statement of the students mentioned above is in line with the results of a survey of several studies that have been described in the introduction above that the implementation of practicum in Indonesian schools is lacking [4]. Efforts should be made so that the frequency of the experiment can be improved by learning performed use the ICARE based student worksheets to make students interact actively in the process of experimentation can further improve the skills and knowledge productively in learning [20].

4. Conclusion
Based on the results of the discussion, the findings of this study can be concluded that the creativity ability of students can be improved through the ICARE practice based on worksheets for conduct physics experiments. Improvement is indicated by an average N-gain score of 0.32 in the medium category, which consists of four, namely N-Gain flexibility is 0.32 with the medium category, fluency is 0.24 with less categories, the indicator of originality is 0.50 with the medium category, and for elaboration is 0.39 with the medium category.

Acknowledgement
Acknowledgements researchers convey DRPM Direktorat Jenderal Penguatan Riset & Pengembangan Kemenristekdikti who has provided research funds to carry out research in order to advance education.

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