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# Designing students' worksheet based on open-ended approach to foster students' creative thinking skills

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**Abstract.** This study aimed at designing an open-ended worksheet to enhance students' creative thinking skills. The study was conducted at one private school in Bandar Lampung, Indonesia. The participants of the study were twenty students of tenth grade students and two physics teachers. This study used descriptive data. Data were collected by analyzing qualitative data, literature and focus group discussion to gain information about students' conceptions of physics in the context of open-ended learning. The result showed that students needed innovative learning resources in form of open ended-based worksheet which could give the students an opportunity to develop various solutions related to physics problem. Therefore, students' creative thinking skill could be improved.

## 1. Introduction

Current educational challenge is that each educational institution should equip their alumni with 21<sup>st</sup> century competencies. Based on Binkley [3], there are ten 21<sup>st</sup> century competencies, some of which are creative thinking skill, problem-solving skill, making decision, effective communication skill, multi-representational skill, information literacy, and ICT literacy (Information and Communication Technology). Besides, according to Manik [11] physics is a science that requires more understanding than memorization, then the key to success in learning Physics is the skill of using the three basic things of physics namely concepts, laws or principles, and theories. In the study of physics, the skill to comprehend the concept of physics is an absolute requirement in achieving the success of physics learning [6].

According to Yuliati [8] in the context of physics learning school is something that should be done by students, not done for students. In learning physics students do not only learn about the concept of physics but students are also required to be able to develop skill to ask questions, compile the explanations, and test the explanations and write them again by using their own language. Therefore, in the process of physics learning needs variety of strategies, methods, learning media and appropriate learning resources in order for students to learn actively so that students' thinking skill can be improved.

According to Sumantri [13], thinking is an activity to find the right knowledge. In physics learning is known as skill of mathematical thinking. Correlating to the concept of thinking, mathematical thinking can be seen as a way to improve understanding of physics by compiling data and information which are obtained by conducting research or assessing mathematical objects. The skill of mathematical thinking



becomes one measure of the achievement of physics learning goals, especially high-order thinking skill, such as critical, creative, logical, analytical, and reflective thinking.

Creative thinking is the expression of an individual uniqueness in interaction with his/her environment. This creative expression reflects originality of an individual. From the unique personal expression can be expected an emergence of new ideas and innovative products and with characteristics such as: ability to guide themselves to a particular object, describe an idea, analyze the ideas and quality of personal work, and create a new idea in solving problems [13].

According to Manik [11] students are less able to solve more complex problems require process of creative thinking. This is also supported by presentation of merely closed ended problem in daily classrooms. Presented problems are designed in such a way until it has only unique answer or only one problem solving. A student can be said as creative person if able to solve a problem with a lot of ways, so that physics can develop student creative thinking way.

According to Munandar [14] creativity is skill to create new combination, based on data, information or elements that exist. Created results are not always new things, but can also be a combination of available things. In addition, Glegg declared that creativity as an action, idea, or product that replace something old into something new [4].

Limitations of physics learning media will certainly disrupt the process of physics learning in the classrooms, especially if the learning media used is only a textbook that only contains text and image that are less interesting. Based on [12], learning media is anything that can be used to transfer message from sender to receiver so it can stimulate attention and interest and willingness of learners so that learning process runs well in order to achieve the learning objectives effectively.

To improve students' creative thinking skill, one of learning resources that can be used is open ended-based worksheet. Worksheet is one of the instructional instruments to convince effectiveness of teaching and learning process [7]. Learning with an open-ended approach can develop idea, creativity and critical attitude of students. Students may develop variety of methods, ways, or approaches in obtaining the answers, making the process more important than results. This will build mindset of cohesiveness and conceptual understanding [2].

The result of interview with some of teachers and students in senior high school showed that the resource of physics learning used is still rare to use open-ended worksheet. Learning based on open ended can help students think creatively, and support understanding of the concept of Physics. An open-ended approach is a learning approach that presents a problem which could be solve by various method or solutions [1]. The open-ended approach gives students an opportunity to acquire the knowledge or experience, find, recognize, and solve problems in various ways. In open-ended approach, the problem is an open ended problem or incomplete problem. While the basics of disclosure are classified into three types, namely: (1) open process which has many correct solutions, (2) open final result which has many correct answers, and (3) the next way to improve is open in which when students have solved the problem, they can develop a new problem by changing the condition of the previous problem (original).

Learning that uses open-ended problems requires worksheet based on open-ended problems. According to Depdiknas [5] worksheet is a student worksheet is a sheet containing tasks that must be done by students, worksheet usually in form of instructions, steps to complete a task, a task that ordered in activity sheet must be clear about the basic competence that has to be achieved. It is also an instrument in which steps are given to students to learn [17]. The matters are activities doing experiment and observation, writing the result of observation, analyzing the data and drawing the conclusion [12]. The use of worksheet will give opportunity for the students to participate actively in learning. The teacher's role as a facilitator cannot be replaced by worksheet. When using worksheet, teachers are responsible for monitoring students' work during learning process.

Based on the description of the problem above, the researcher designed a learning resource in form of worksheet that could present attractive physics learning using open-ended approach. The author conducted a study aimed at designing an open-ended worksheet to develop students' creative thinking skill.

## 2. Methods

This research was conducted at one private school at Bandar Lampung involving twenty-four 10<sup>th</sup> grade students as respondents. Respondents were grouped into three groups based on their achievement: high, medium and low achiever students. FGD respondents involved can be seen in Table 1.

**Table 1.** Coding of Focus Group Respondents

Focus Group Respondents	Total's Respondents	Allocated Code
High Achiever Students	8	HA
Middle Achiever Students	8	MA
Low Achiever Students	8	LA

The stages of this research were formulating problems, collecting data, and designing worksheet of Physics learning. Data collection was done by analyzing these components: qualitative data obtained from interview, literature studies from various sources, and focus group discussion (FGD). FGD is a method and technique for collecting qualitative data in which a group of people discuss a particular problem or topic guided by a facilitator or moderator. FGD aims at exploring and obtaining a variety of information about a particular problem or topic that may be viewed differently by different explanations. The FGD notes were transcribed and the data were analyzed by content analysis. Subsequently, this resulted in the data being manifest code which identifies the underlying meaning of the topic [15]. In addition, as the informants in the focus groups are all nominated effective guidance teachers, those who have little training in counseling and guidance [16]. The present study demonstrates the possible usefulness of the focus group methodology in investigating perceptions of elements of effective school counseling and guidance [17]. According to [16], when the research experts examined using group focus and / or cognitive interviews as a first step or as an additional source of data for several research instruments.

In the FGD realization process, the questions in each group are open-ended questions and can freely express opinions on the question asked. The researcher engages creative ideas from students, the questions asked consist of four questions: (1) learning resources that help students in learning Physics, (2) the criteria of Physics learning worksheet to be more interesting, (3) learning resources that facilitate open problem solving skills (open ended problem), (4) student's expectations to learn the material of Physics easily. The results of the discussion will be collected and analyzed so as to produce the design of learning resources in form of Student Worksheet.

## 3. Result and Discussion

Students' opinions about learning resources that can help students in learning physics are: a set of book of physics formulas that have been prepared in detail, modules and student worksheets (that have been designed to help students solve physics problems, as well as practicum activities, and able to understand the concept of physics (HA). A book includes complete material in which there are complex exercises and a power point media with simple and easy-to-understand (MA). Physical learning resources are actually very much like worksheet physics in which facilitate the activity in developing creativity in solving the problem of physics (LA).

Students' opinions about the criteria of physics learning worksheet to be more interesting are: first can be shown from the interesting cover of worksheet, complete content that contains material summary, activity instruction and exercise question (HA). Worksheet uses language which is easy-to-understand, along with interesting picture and interactive and ICT-based (MA). Worksheet contains a complete summary of material, with pictures, sample questions, and exercise questions (LA) can be used independently.

Students' opinions about open-ended learning sources are: if a worksheet is designed based on open-ended problem, it will make students more motivated to find solution so it can develop their creativity in thinking (HA). Worksheet based on open-ended will increase students' interests and challenge students to solve the problem without worrying that the answer will be wrong because it led students to

reach correct answer (MA). The worksheet is very scarce until it makes students become curious, because usually open-ended approach is being used in solving math problems. This opinion is supported by Manik [11] which clarifies that learning method that open-ended approach is more effective to improve skill of creative thinking than with conventional learning.

Furthermore, students' opinions about content of the worksheet is that open ended problem part of worksheet was placed at the beginning part of worksheet, so the creativity of students directly accelerated since the beginning of learning (HA). The open-ended content was placed in the middle of the worksheet so the students are not surprised, in the beginning part the students were given closed problem and in the final part is given the conclusion (MA). Meanwhile, according to the group (LA) open-ended content was placed at the end part after the students understand the material and closed problem solving in order to avoid the confusion when solving open ended problem.

Regarding students' opinions about students' expectations to learn physics material becomes easy was from the resource of learning, learning resource should be innovative and interesting. Worksheet should contain brief explanations, practice questions. In addition, the teachers should be more attractive and able to give an inspiration to students (HA). Learning resources used must be complete. In addition to deal with theory, physics lesson must also be enriched with practicum so that students can apply the theory that has been obtained in the class (MA). Teachers should give attractive and detailed materials, and provide practice questions that could develop students' creative thinking. The worksheet used should help students understand the material easily, use simple language with scientific explanation and discussion forum (LA).

Based on the four items of questions that were discussed in the FGD which is followed by 24 students as respondents, result of composition of open ended worksheet based present will be developed as shown in Table 2.

**Table 2.** Student Worksheet Content Structures

No	Content	Description
1	Summary of Material	Consists of some brief material on the worksheet introduction
2	Open ended problem	Includes various problems which are contained in Physics presented openly (open ended)
3	Constructing the idea	Finding and arranging the solutions of open ended questions so that students are able to improve their creative thinking skills
4	Exploration	After finding the idea and solution, then students discuss with their group to compare the solutions they make.
5	Presentation	Delivering exploration results in form of conclusions.

Based on the FGD result, the module design was found in 5 contents that should be there in open - ended worksheet. The structure of the worksheet consists of a summary part of material, open-ended questions, constructing ideas, exploration, and presentation sections. To improve students' creative thinking skill, the worksheet should be equipped with open-ended problem, construction of ideas, exploration and presentation part. According to Manik [11] application of open-ended approach is effective to improve students' creative thinking skill.

Open-ended problem part comprised of physics questions that are presented in open-ended form. Just as mathematics, Physics can be presented in open ended form because Physics really need mathematical calculation in solving physics questions. Manik [11] stated that the average absorption of students in experimental class that was using open-ended approach in the effective category with the percentage of 77.19% meanwhile in the control class was obtained the average student' absorption in the category less effective with a percentage of 40.54 %. Yuliana [18] stated that one of way to enhance students' creative thinking skill is by presenting open-ended tasks and questions.

The last three parts of the worksheet consisted of construction of ideas, exploration and presentation are important stages to develop students' creative thinking skills. Aspect of constructing ideas and



exploration are the most desirable aspects, nearly 80% of students thought that the exploration via discussion lead students to express their opinions about achieved solution. This method is effective in training and developing creative thinking skills, because in discussion there is an exchange of opinions. In the process of exchanging opinions, students can express, consider, reject or accept, combine their own and other and determine its effectiveness. Also discussion also might lead students to draw conclusion that usually find the new solution. These are the things that ultimately develop creative thinking skill of students. At last, it grows the students' creative thinking. It is in line with Noer [9] who stated that students' creative thinking ability in open-ended learning environment are higher than that of in conventional environment.

The FGD results showed that the worksheet structure is in form of an open ended problem statement. With the presence of open-ended part, then the creativity of students in solving the problems of physics will be able to develop. Even, the open-ended approach both develop creative thinking and stimulate other effect such as improve students' confidence [9].

#### 4. Conclusion

Based on the above explanation, the developed open ended-based worksheet was able to develop students' creative thinking skills containing aspect of material summary, open ended problem, exploration, and presentation. The design of worksheet was developed through focus group discussion (FGD) which involved tenth grade students. The FGD results were described and analysed qualitatively so as to develop an open ended-based worksheet that can develop students' creative thinking skill.

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