

# Improving Students' Cognitive Abilities And Creative Thinking Skills On Temperature And Heat Concepts Through An Exelearning-Assisted Problem Based Learning

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**Abstract:** This study was aim to investigate the improvement of students' cognitive abilities and creative thinking skills who was taught using an exelearning-assisted problem based learning model. A quasi-experimental method was used to engage 48 ninth-grade science students of an Islamic Senior High School at Bandung. Data were collected by using a cognitive test and creative thinking skills test that administered at the beginning and the end of the instruction, analyzed by using the normalized gain. Students who had an exelearning-assisted project based learning model demonstrated significantly higher average normalized gain on cognitive test and creative thinking skills test than those who did not have. Correlation coefficient between the experimental group students' cognitive abilities and creative thinking skill was  $r_{xy} = 0,55$  with determination coefficient  $R=30.67\%$ . The findings showed statistically significant differences between the improvement of the experimental group compare to the control group. Most students responded excited and motivated when they was taught using an exelearning-assisted problem based learning model.

**Index Terms:** exelearning, problem based learning, cognitive abilities, creative thinking skills

## 1 INTRODUCTION

Learning by using web or electronic learning (e-learning) has unlimited space and time to provide an effective learning whenever we want to access it if we have computer, tablet, and mobile phone that connected to the internet. As well as student-teacher interaction become easier in real time. Some previous studies have showed that Moodle as an e-learning media give positive contributions to help students build their knowledge and to promote students' positive attitude in direct the discussion and cooperating with their partners [1]. One of supporting facilities in conducting a study using the web online is to provide highly bandwidth connectivity to avoid a problem when accessed simultaneously by users, student and teacher. To solve that bandwidth connectivity, a free service provider engaged in education create an innovation program named the Elearning HTML Editor (exelearning), an environment of authoring to help teacher and academics in designing, developing, and publishing teaching web-based learning materials without being highly mastered an HTML program or complicated web-publishing application [2]. Web-based exelearning program is built under an open source licensed program which dedicated to the creative and innovative learning media development that easily without mastering xhtml program, a web-based authoring offline which does not require bandwidth capacity to connect internet. The use and development of authoring program, exelearning as free software alternative becomes something that should be mastered by the creative teacher in learning.

Those developments certainly should appropriate with mandated curriculum and the goals to be achieved. Creating learning media by using exelearning has an education value to develop students' achievement and motivation should be mastered by teacher [3]. iDevice provides basic format and editing functions that consist of a series of reading activity, foreknowledge, download materials and interactive exercise. The use of educational features in exelearning can develop student's achievement, both individually or in groups, compared to the traditional method. In addition, exelearning also help to develop teacher's skill in designing learning materials to provide high quality teaching and learning. Some teaching skills that should be mastered by teacher, such as good interactive publication, connectedness between teaching method, encouraging students to understand clearly cognitive abilities through discussion, social interaction that often supported by computer device and helping students compare their understanding with their friends to be scientifically accepted [4]. One of cognitive processes (remembering, understanding, analyzing, evaluating, and creating) that is emphasized in the high school and the university is understanding. Students who have good understanding would be able to construct a meaning from learning messages, in oral, written or graphics, which present through teaching, textbook, or computer[5]. Creative thinking is a thinking process that focuses on exploring an idea, creating the probability and finding the correct answer, not only one corrected answer [6]. In Physics, creative thinking is used to derive the basic principles of physic and its following problem [7]. A preliminary study to obtain students' prior cognitive thinking skills was conducted by providing a learning video that demonstrate heat transfer phenomena by heating a soda can with gas stove and student was asked to observe and explain the process. Students showed the average of each creative thinking skills indicator resperctively fluently 50.05%, flexibility 43.24%, originality 10.81%, and elaboration 18.92%. Lower average on originality and elaboration indicator need to develop by implementing an innovative learning materials of physic in order that it probably makes students using their creative thinking abilities actively [8]. Problem based learning

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intentionally was developed to help students in enhancing their thinking ability, problem solving ability, and intellectual skills; learning adult person roles with experience through various real situations or simulated situation; and becoming an independent and autonomous learner [9]. Previous study that compare online problem based learning with Moodle and traditional problem based learning with lecture showed that online problem based learning with Moodle is able to develop creative thinking skills, particularly flexibility, originality, and elaboration indicator. However, traditional problem based learning is able to develop fluency indicator higher than online problem based learning [10]. Another study using authoring environment to improve creative thinking suggest that hypermedia authoring is an alternative to facilitate the development of students' cognitive abilities and motivate them to learn. Students' involvement in making assignment has great potential to improve their creative thinking [11].

## 2 EXEARNING-ASSISTED PROBLEM BASED LEARNING

### 2.1 Exelearning: An electronic textbook

Exelearning has developed to solve some bandwidth limitations. There are many web authoring softwares requires fairly steep learning curve, not intuitive or not designed to publish the learning content. As a result, teacher and academics cannot adopt the technology to publish online learning material. Exelearning was built to provide intuitive and easy tool for teachers to publish professional webpage for teaching and learning. Most of content management and learning system management utilize a web server centered model, so it need to connectivity for authoring. This problem gives an obstacle to the writer who has low connection in bandwidth or does not have connectivity. Exelearning has been developed as an authoring offline tool without requirement to connect with bandwidth. Exelearning facilitates user to create an appropriate learning structure fit with their content needed and build the flexible, easy, and renewable resources. Following Fig.1 describes more clearly the exelearning homepage window which consist of experimental, interactive activities, non-interactive activities, non-textual information, and textual information.

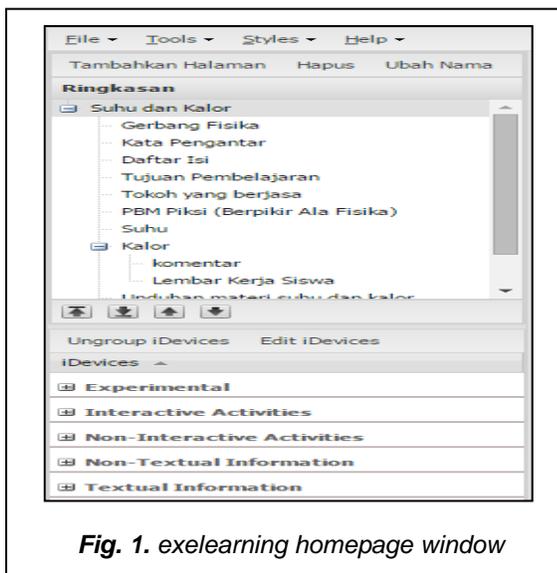


Fig. 1. exelearning homepage window

### 2.2 Problem Based Learning on Temperature and Heat Concepts

According to Arend [9], Problem Based Learning stages can be sorted in the Table 1, as follows:

TABLE 1  
PROBLEM BASED LEARNING STAGES

Stage	Learning Process
Stage 1 Giving an orientation about the problem to students	Teacher explains learning purpose and logistic required, and motivate the students to involve in selected problem solving activities
Stage 2 Organizing students to learn	Teacher helps the students define and organize learning assignment that related to the problem
Stage 3 Individual and group guided investigation	Teacher encourages students to collect appropriate information, conduct the experiment to get the explanation and problem solving
Stage 4 Developing and providing attainments	Teacher helps students to design and prepare the an appropriate creation, and help them communicate each other
Stage 5 Analyzing and evaluating problem solving process	Teacher helps student to reflect and evaluate their investigation and any processes used.

The role of teacher in this research as facilitator to make students can do the activity in constructing their knowledge through the previous knowledge. In particular, the role of teacher and student in problem based learning as follows:

1. Teacher gives motivation and stimulus to the students using picture
2. Teacher introduces a problem to the students in the beginning of the instruction
3. Student learns to create necessary things to solve problems
4. Student builds the knowledge and develop the problem solving skills during problem solving process,
5. Student set their learning independently to find out the solution of the given problem
6. Teacher acts as a facilitator in series of activities with the indicator:
  - a. Provide cognitive support, by asking a question that explores the knowledge and procedures required to solve the problem
  - b. Metacognitive support by asking the question on related topics, planning, monitoring, controlling, and evaluation of problem solving process.
  - c. Procedural support in the suitable form between challenge problem and students' ability, monitoring group's development, supporting students in problem solving process and evaluating students' performance.

Process in creating learning materials on temperature and heat concepts utilizing exelearning consist of some blocks. The first block is starting with cover, introduction, learning objectives and temperature and heat concept maps. In the activity stage of this block is started by presenting the daily contextual problem through picture or video. The motivation block contains a physicist figure in the field of temperature and heat, to motivate students' learning motivation. The second block is the organizing student stage, where learning material is presented and provided in the download area as student

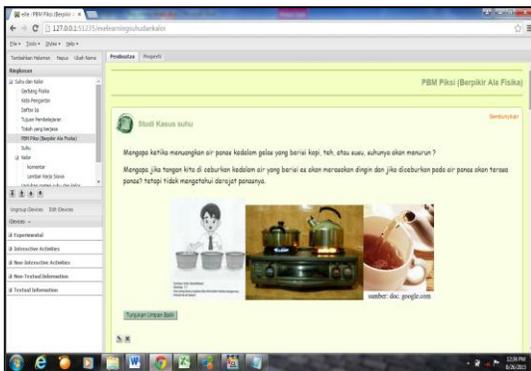
further readings. A file can be downloaded by clicking on the underlined text that is available in flash format, document, and power point. The third block is the assignment stage, where in this stage student explains about heat problem, then communicate it. This assignment block can be divided into case study and exercise. In case study is presented a problem. In analyzing and evaluating students' performance, students' cognitive abilities and creative thinking skills exercises is presented in the quiz block. The quiz is presented in the multiple-choice form and completely completion solution and feedback available.

**2.3 The implementation stage of exelearning-assisted PBL**

Student in the experimental group have an exelearning-assisted problem based learning model during three lesson meetings, with the PBL stage as follows:

1. In this stage, students are taught how to open an exelearning learning materials through Wi-Fi that available on computer, laptop or Android-based smartphone, Windowsphone. Choose Wi-Fi connectify-me, enter the password 12345678. Then open internet browser and type an IP address.192.168.67.1/ebukuajar
2. First block starts with learning objectives and concept maps, activity stages, student motivation and problem orientation.
3. Second block is the stage of organizing students, where it delivered the presentation of learning material;
4. Third block is the stage of assignment, where student was asked to explain and communicate the problem.
5. Last, the stage of analyzing and evaluating students' performance provided the exercise.

All of those stages were shown respectively in Fig. 2(a),(b),(c).



(a)



(b)



(c)

**Fig. 2.** Exelearning page of (a) problem orientation, (b) learning material on temperature and heat concept, and (c) multiple choice quiz

**3 METHOD**

A quasi experimental method with the static group pretest-posttest design [14] was used to involve randomly selected 48 ninth-grade students of Islamic Senior High School in Bandung, which divided into two groups, respectively 24 students each experimental and control group in academic year 2014/2015. Sample was given cognitive and creative thinking test in the beginning and the end of the instruction. Student in the experimental group who have exelearning-assisted problem based learning model, while in the control group who have problem based learning without exelearning on the temperature and heat concepts. The improvement of students' cognitive abilities and creative thinking skills on temperature and heat concept was calculated by using normalized gain score. It is intended to avoid misinterpretation of the acquisition students' gain score. To obtain normalized gain score was used the formula that proposed by Hake [12] as follow:

$$\langle g \rangle = \frac{\langle Sf \rangle - \langle Si \rangle}{\langle Ti \rangle - \langle Si \rangle} \cdot 1$$

where:

- <g> = average normalized gain
- <Ti> = ideal score
- <Sf> = posttest score
- <Si> = pretest score

The averaged normalized gain are interpreted to determine the learning effectiveness criteria as shown in Table 2.

**TABLE 2**  
THE AVERAGE NORMALIZED GAIN INTERPRETATION

Average normalized gain <g>	Criteria
$\langle g \rangle \leq 0,7$	High
$0,3 \leq \langle g \rangle < 0,7$	Medium
$\langle g \rangle < 0,3$	Low

While correlation between students' cognitive ability and creative thinking was analyzed by using a correlation Pearson Product Moment test [13]. Pearson correlation equation was given by Eq.2, while Eq. 3 was used to test the significance of the relationship between two variables. To find out how big the

contribution of two specific variables can use the determination coefficient (R) by Eq. 4

(Eq. 2)

$$r_{xy} = \frac{n\sum x_i y_i - (\sum x_i)(\sum y_i)}{\sqrt{\{n\sum x_i^2 - (\sum x_i)^2\}\{n\sum y_i^2 - (\sum y_i)^2\}}}$$

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad (\text{Eq. 3})$$

$$R = (r_{xy})^2 \times 100\% \quad (\text{Eq. 4})$$

#### 4 RESULT AND DISCUSSION

In this section, we describe the comparison of students' cognitive ability and creative thinking skills between students who had exelearning-assisted problem based learning and they have not. Cognitive and creative thinking test was administered in the beginning and the end of the instruction.

**TABLE 3**

THE AVERAGE NORMALIZED GAIN SCORE OF COGNITIVE ABILITY FOR EXPERIMENTAL AND CONTROL GROUP

Group	Cognitive ability test				<g>
	Pretest		Posttest		
	Mean	S.D.	Mean	S.D	
Experiment	21.46	6.83	48.75	8.24	0.34
Control	21.88	8.82	41.04	11.70	0.24

Based on the data presented in the Table 3, the average normalized gain score of students' cognitive ability was 0.34 and 0.24, respectively for experimental and control group. While, the average normalized gain score of students' creative thinking for experimental and control group was 0.34 and 0.25, respectively. The experimental group n-gain score was significantly higher than the control group n-gain score. Comparison between students' creative thinking score for both groups can be shown in the Table 4.

**TABLE 4**

THE AVERAGE NORMALIZED GAIN SCORE OF CREATIVE THINKING SKILL FOR EXPERIMENTAL AND CONTROL GROUP

Group	Creative Thinking Skills				<g>
	Pretest		Posttest		
	Mean	S.D	Mean	S.D	
Experiment	50.82	11.73	67.66	11.61	0.34
Control	45.57	15.80	60.68	14.45	0.25

The improvement of fluency indicator in creative thinking skill, particularly in the experimental group, showed that student was able to ask a lot of question as much as possible through the given problem description. The ability to write the cause of an event was improved as 19%, while for original thinking, particularly guessing the impact indicators, where the students give an authentic/unique answer was also improved as 18%. As for complex thinking, 43% student can write changes or addition to develop a product. While for control group, the increased of creative thinking indicator which consist of fluency indicator in asking question, originality in guessing the

impact, and complex thinking to develop a product were 44%, 17%, 32%, in respectively. Then flexibility thinking in the guessing a cause showed an inconsistencies concept was 6%. The correlation between students' cognitive abilities and creative thinking showed Pearson Product Moment coefficient  $r_{xy} = 0.55$  with  $t_{count} = 3.089$  which is bigger than  $t_{table} = 1.717$ . Thus, it can be said that the cognitive ability and creative thinking skills has significant correlation. To find out how much the contribution of the cognitive abilities that influence creative thinking skills process was calculated by using the coefficient determination,  $R = (0.55)^2 \times 100\% = 30.67\%$ . It means that students' cognitive abilities influenced their creative thinking skills as much 30.67%, while the rest comes from the other variables outside studied variables.

#### 5 CONCLUSION

Based on the discussion above, it showed that the improvement of students' cognitive abilities and creative thinking skills that is taught by using exelearning-assisted problem based learning was significantly higher than student who had problem based learning without exelearning. There is also positive correlation between students' cognitive abilities and creative thinking skills which lies in medium level of significant. Most of students also demonstrate highly motivation and excitement when they was taught using an exelearning-assisted problem based learning model.

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