Enhancing critical thinking through the science learning on using interactive problem based module

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Abstract. Facing the 21st century, higher order thinking skills are becoming a valuable thing to be learned. This is why learning science has to be designed on using innovative models, approaches, and Media. The R and D research on using ADDIE design was done to develop the interactive problem based module on population and environmental pollution topics. After validation process on the conceptual aspects as well as the learning and techno-pedagogic aspects, the module was then implemented in science learning at secondary school, to enhance critical thinking skills. The research shows that the module is very effective to use as a supporting material in order to enhance critical thinking skills. Based on the students’ response, the media was very helpful to student to learn science as well as to enhance the skill in how to practice IT.

1. Introduction
Critical thinking is a 21st century skill that needs to be trained on students. Exercising critical thinking skills can provide space for students having problem-solving skills [1][2][3][4]. Critical thinking skills include other higher order thinking skills can have a positive impact such as engaging students into open mindedness, critical thinker, always evaluating incoming information, and always being skeptical [5][6][7]. This critical ability and skepticism are needed to anticipate the rapid flow of information. Maintaining a healthy skepticism of fish information allows students to “filter” acceptable information. Practicing critical thinking skills should be done in every learning opportunity, including science learning [8].

Based on the research results, the use of media in learning is very potential to build critical thinking skills and problem solving [9]. One of media that can be used is visual-based media [10]. Module is one visual media that can serve as teaching materials in which have affective function. Reading text and observing picture embedded can arise emotion and attitude of student, for example the information concerning social problem. The problem-based visual learning module can complement the function of the media, as well as the source of learning also contributes to the effort of improving critical thinking skills, problem solving, and fulfilling the function of attention, affective, cognitive and compensatory [11].

The interactive problem based module (IPBM) has developed in previous research on environmental pollution material, and has assessed by experts and tested limited to secondary school students. This article reports the use of interactive problem based module in science learning, and its impact on students’ critical thinking skills.
2. Method

The descriptive method was used in this research [12], which aims to reveal how the implementation of IPBM of environmental pollution give the impact to enhancing critical thinking skills as well as the students’ achievement. The participants were all students of grade 7 in one of junior high school Bogor in academic year 2016-2017. Purposive sampling technique, with certain consideration based on the criteria was applied based on research objectives. Furthermore, the method of pre-experiment was used to see the impact of the use of IPBM on students' critical thinking skills as well as students’ achievement. The students' responses were also investigated to support the results of the study, which were conducted using questionnaires and interviews. The IPBM has several characteristics such as; pedagogy, content, technical and aesthetic aspects which is tailored to the character of the student. In terms of technical IPBM is self-instructional, adaptive, and user friendly.

The designed IPBM has been tested feasibility by the expert ie 2 science lecturers and 4 science teachers. The validation data obtained is used as a benchmark of the module both in terms of ease of use and material interrelations. Based on media validation data, the lecturers validator gave a score of 97.37% with very good category. Based on data content validation of the IPBM, it was obtained a percentage of 94.32% with very good category. The validation by the science teacher of SMP gave the assessment in very good category. The average percentage of four aspects is equal to 87.11% with details as follows: Pedagogic aspect 84.38%, content Aspect 89.06%, 89.58% technical aspect, and aesthetic Aspect 85.42 %.

3. Result and discussion

3.1. The Use of IPBM in Science Learning on Environment Pollution Theme

The IPBM on the theme of environmental pollution that have developed is intended for students of grade 7 (secondary school). The module are arranged as a teaching material that can bridge the development of critical thinking skills and of concept mastery of student. The IPBM covers materials of Population Density and Environmental Pollution where various problems are found in daily life. Promoting problems that are close to everyday life can stimulate students in thinking and provide solutions to existing problems. The IPBM has assessed based on the fulfillment of aspects of pedagogy, content, engineering, and aesthetics.

From the pedagogic aspect, IPBM reflects the learning activities. At the introduction stage video on population density, forest fires and environmental pollution are presented to initiate student learning. From the content side, the IPBM is begun by presenting factual samples, followed by questions of problems that students must think about solutions. Students are also directed to create a mind map, as well as working out some questions. The questions consist of real problems, so student have to find for solution based on their understanding to relevant concepts. In the closing stages, students follow an interactive evaluation related to concepts as well as critical thinking questions.

In terms of technical aspects, IPBM has the characteristics such as self-instructional, adaptive, and user friendly. The IPBM can also be operated by students their self even without teacher assistance, anywhere and anytime they want to learn. In aesthetic aspects, IPBM has an interesting design for students with color composition in accordance with the characteristics of junior high school students. Video support and relevant images are displayed to support concept clarity. The Interesting and challenging questions are presented to practice critical thinking skills as well as mastering the concept of science.

3.2. The impact of IPBM to the Students' critical thinking skills and students’ achievement

The effectiveness test of IPBM was done in one of secondary shool at Bogor, West Java-Indonesia. Held at even semester of academic year 2016-2017, the IPBM was applied in Population Density and Environmental Pollution learning. The target were 33 students of grade 7. The data used were obtained from the pretest and posttest activities given to the students with 2 types of questions, multiple choice
(MC) for the students' concept of mastery and description to know the critical thinking skills (CTS) of the students.

Table 1 is a result of pretest and posttest analysis on critical thinking skills indicator tested in the form of a description problem, which explores four main indicators: 1) provides a simple explanation, 2) makes inference, 3) provides further explanation, and 4) sets the strategy.

| No. | Data Implementation | Pretest | Posttest |
|-----|---------------------|---------|----------|
| 1   | Number of Student   | 33      | 33       |
| 2   | Average of critical thinking skills score | 41,89 | 70,9 |
| 3   | The Highest score   | 77,5    | 92,5     |
| 4   | The lowest score    | 17,5    | 45       |
| 5   | %N-Gain             | 48      |          |
| 6   | N-gain              | 0,48    |          |

Table 1. Analysis result of Pretest dan Postest for critical thinking skills.

To find out more clearly, Table 2 shows the average score of pretest, posttest, and N-gain in students' critical thinking skills of each indicator.

| No | Indicator                                | Item test | score | Max score | % N-Gain | Criteria |
|----|------------------------------------------|-----------|-------|-----------|----------|----------|
|    |                                           |           | Pre-Test | Post-Test |          |          |
| 1  | provides a simple explanation            | 1, 2, 10 | 141    | 273       | 0,52     | 51,76    | moderate |
| 2  | makes inference                          | 3, 9     | 103    | 157       | 0,34     | 33,54    | moderate |
| 3  | provides further explanation             | 7, 8     | 121    | 199       | 0,55     | 54,55    | moderate |
| 4  | sets the strategy                        | 4, 5, 6  | 188    | 307       | 0,57     | 57,21    | moderate |
|    | Average                                  |           |        |           | 0,49     | 49,27    |          |
|    | Category                                 |           |        |           |          | moderate |

*) Based on Hake, 1999 [13].

In line with CTS, overall student achievement shows an increase in the moderate category (questions vary between levels 1 to 4 of Bloom Taxonomy), as shown by table 3.

| No | Data Implementation | Pretest | Posttest |
|----|---------------------|---------|----------|
| 1  | Number of student   | 33      | 33       |
| 2  | Score average       | 55,87   | 76,52    |
| 3  | The highest score   | 81,25   | 93,75    |
| 4  | The lowest score    | 43,75   | 60       |
| 5  | Gain                | 47      |          |
| 6  | N-gain              | 0,47    |          |

Table 3. Data analysis of pre-posttest of students' achievement.

The improving of thinking skills can be assumed as the impact of the increase of students’ achievement (conceptual understanding), or vice versa. However, the research assumption that both achievement occur due to the use of IPBM. IPBM is packaged very attractive and based on real problems in everyday
life so it makes students interest to learn the concept. The question of exercise with the context of the problems in everyday life leads to the CTS of students. Mastery of concepts is also contributes greatly to thinking skills. This is in line with the statement proposed by College of Education, University of Washington (2001) in [9], which stated that the use of real-life problems as students' thought contexts can help them not only to solve problems but also to understand the important knowledge and concepts.

In line with these findings, a similar study by [1] proved that the learning model that puts students in equity on using various approaches such as contextual, science technology and society, free inquiry, and by using interactive methods through critical and analytical discussions, collaborative, inductive, deductive, and reflective, can enhance critical thinking skills [14][15][16][17]. The ability to think critically is very important for understanding certain notions, with basic skills of using relationships (partial and whole patterns, analysis and synthesis, sequence and sequence, logical deduction), transformation (analogies, metaphors, logical inductions) and causalities (predictions, conclusions, assessments, evaluations). Similarly, reference [18] said that the PBL approach is recognized as an active approach in developing technical or cognitive skills of students such as problem solving, thinking critical and creative knowledge and application of knowledge, as well as process skills such as project management and time, teamwork and leadership, languages (written and oral).

The result of research is reinforced by the result of questionnaire of student response. Almost all students said that they enjoy using IPBM because of some reasons, they are interesting because IT-based and interactive, the content of IPBM is very close to their daily life, so they are happy to find solutions to the problems posed by the module. They also love the exercise questions with the feedback given, so as to strengthen the concept of mastery. In line with the results of this study, reference [11] and [10] reveal that media can serve as a function of attention, affective function, cognitive function, and compensatory function.

4. Conclusion
Interactive Problem Based Module (IPBM) for 7th grader on Population Density and Environmental Pollution has been developed with attention to some aspects such as pedagogy, content, technical and aesthetic. The IPBM was also made in accordance with the character of students. The use of IPBM in learning environment pollution has enhanced both of critical thinking skills and students’ achievement in moderate category. In addition, the supporting of IPBM in learning can be seen from the very high students’ response to the learning. Students love learning by using interactive technology along with IPBM display which they find very interesting.

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