Enhancing Students’ Critical Thinking Skills through Multimedia Based Integrated Instruction (MBI₂) on Solar System Concept

S S Bhakti a), A H Setyadin, S R Hidayat, Hermawan, A Zulfikar, N J Fratiwi, S A Amalia, D S Juhaedah, F N Sholihat, N Aff, D T Chandra, P Siahaan, E Suhendi, I Kaniawati, A Samsudin

Departemen Pendidikan Fisika, Universitas Pendidikan Indonesia, Bandung 40154

a) E-mail : satria.seto.bhakti@student.upi.edu

Abstract. The solar system is one of the intangible learning materials of science because the phenomena that occur could not be presented directly in the classroom such as members of the solar system, the repetition of day and night, the phases of moon, and the eclipse. This resulted is student difficulties to understanding the solar system concept. To overcome these problems, the researcher aims to develop learning media that can also enhance the Critical Thinking Skills (CTS) of students through Multimedia Based Integrated Instruction (MBI₂). MBI₂ is an integrated multimedia computer which contains learning materials including video, animation and simulation, learning tools, e-books and assessment. To collect and analyze the data genuinely and comprehensively, researchers utilized a pre-experimental method with one group pretest-posttest design for 36 students as research subject. The results of research showed that (1) 43% of students were able to identifying/formulating the criteria of possible answers, (2) 32% of students could giving a reason, (3) 39% of students could giving a hypothesis, (4) 41% students could identifying assumptions or conclusions, (5) 36% of students could select the possible criteria as a solution to the problems. Based on data analysis, it can be concluded that MBI₂ could significantly enhance the critical thinking skills of junior high school students on solar system.

1. Introduction

In the 21st century, the development of science and technology has been growing rapidly. This development had given an impact in various areas of life, one of them in education area. In education area, the development of science and technology is characterized by various learning media, especially learning media that utilize the latest technology such as computers [1, 2, 3]. The development of science and technology in 21st also requires a number of life skills that must be possessed by everyone, one of skills is critical thinking skills.

Critical thinking skills has been defined as a skill of taking responsibility and control of our own mind [4], or it as a logical and reflective skills thought which focuses on a decision in what to believe and what to do [5]. Critical thinking skills also belong to High-Order Thinking (HOT) level Skills [6]. According to Ennis [5] there are five aspect of critical thinking skills: (1) giving a basic explanation, (2) build basic skills, (3) conclude, (4) making more explanation and (5) strategies and tactics.
Critical thinking skill is indispensable in physics learning, because in physics learning identical with investigation activities on issues ranging from observing, formulating problems, collecting data, processing and analyzing data, and concluding. However, in reality the implementation of learning processes is less encouraging in the attainment of thinking skills. Most of the learning process in the classroom is directed to the ability of students only to memorize information. So many problems that arise encourage students to get good values, from the results of exams given based on what they memorized.

In addition, the use of computer-based learning media is still rarely applied in physics learning. Whereas most of the concept in the study of physics is abstract, one of which is the solar system concept. When the learning process takes place, phenomena that occur in the solar system couldn’t be presented directly in the classroom. Such as members of the solar system, the repetition of day and night, the phases of moon, and the eclipse. As a result students get only information the solar system concept based on teacher explanations, without getting a image in real phenomena of the solar system that occurred.

Based the problem, the researcher aims to develop solar system learning media that can also enhance the Critical Thinking Skills (CTS) of students. It called Multimedia Based Integrated Instruction (MBI). MBI is an integrated multimedia computer which contains learning materials including curriculum, lesson plan, phenomena videos, animation and simulation, learning tools, e-books and assessment. All the facilities available in MBI assist teachers in preparing and implementing the learning process. In addition, the facilities of video, animation and simulation help students to understanding the material more clearly.

2. Research Methodology

In this study, utilized method of research pre-experimental design with one group pretest-posttest design. This Research involving 36 students of seventh grade at one of junior high school in Bandung. Following the scheme of one-group pretest-posttest design is shown in the Figure 1.

| O₁ | X | O₂ |
|----|---|----|
| Pre-test | Treatment | Post-test |

**Figure 1.** One Group Pretest-Posttest Design

Based Figure 1, First students asked to work pretest on multiple-choice questions. This is done to obtain an initial knowledge of the students before being given treatment. One example of the instrument used to measure critical thinking skills as follows.

![Critical Thinking Skills Test Items](image)

**Figure 2.** Example Critical Thinking Skills Test Items
Furthermore, students are given learning treatment by using MBI₂ four times a meeting. There are four sub-items discussed during the four meetings: (1) characteristic of component solar system, (2) Rotation and Revolution of Earth, (3) Moon Phase and Eclipse, and (4) satellite. Following the MBI₂ display is shown in Figure 3 below.

![Figure 3](image)

(a) Principal Menu  (b) Material Menu: An Example of animation repetition day and night

**Explanation**

On Principal menu, there are eight menu consisting: (1) guideline menua, (2) curriculum menu, (3) Phenomena menu, (4) material menu, (5) work sheet menu, (6) Concept map menu, (7) evaluation menu, and (8) E-book menu.

**Figure 3. Display of Multimedia Based Integrated Instruction (MBI₂)**

After all the materials are discussed, students asked to work on posttest issues of multiple choice as in the pretest. Subsequently, the effect of MBI₂ learning on students’ critical thinking skills was determined by using normalized gain analysis <g> as follows.

\[ < g > = \frac{\text{Score posttest} – \text{Score pretest}}{\text{Score ideal} – \text{Score pretest}} \]

Category of normalized gain which proposed by Hake [13] can be seen Table 1.

| N-gain <g>   | Category   |
|--------------|------------|
| <g> ≤ 0,3    | Low        |
| 0,3 < <g> > 0,7 | Moderate   |
| <g> ≥ 0,7    | High       |

### 3. Result and Discussion

Overall critical thinking skills of learners increased after the application of learning using MBI₂. Enhancing critical thinking skills as a whole reached the moderate category with an N-gain of 0.61 is shown in Table 2.

| Average Score | Ideal Score | N-Gain | Category |
|---------------|-------------|--------|----------|
| Pre-test      | Post-test   |        |          |
| 7.97          | 15.33       | 20     | 0.61     | Moderate |
Enhancing of students' critical thinking ability is also observed from each indicator of critical thinking skills studied. In this study, there are five indicators of critical thinking ability observed include: (1) Identifying/Formulating the Criteria of Possible Answer, (2) Giving Reason, (3) Giving Hypothesis, (4) Identifying Assumptions/Conclusions, and (5) Selects possible criteria as a solution to the problem. Enhancing Students' CTS shown in Table 3 below.

**Table 3.** Enhancing Students' Critical Thinking Skill Based Each Indicator

| No | Indicator of CTS                               | Average Score | N-Gain | Category |
|----|-----------------------------------------------|---------------|--------|----------|
| 1  | Identifying/Formulating The Criteria of Possible Answer | 1.56 | 3.14   | 0.43     | Moderate |
| 2  | Giving Reason                                 | 1.94 | 3.11   | 0.32     | Moderate |
| 3  | Giving Hypothesis                             | 1.50 | 2.97   | 0.39     | Moderate |
| 4  | Identifying Assumptions/Conclusions           | 1.14 | 2.89   | 0.41     | Moderate |
| 5  | Selects possible criteria as a solution to the problem | 1.92 | 3.19   | 0.36     | Moderate |

Based on Table 3, shows that the five indicators of critical thinking skills have increased in the moderate category. For more details can be seen in Figure 4 below.

![Figure 4](image-url)  
**Figure 4.** Enhancing of each Critical Thinking Skills Indicators

Based on Figure 4, the highest increase is in CTS 1 (the indicators identifying or formulating possible criteria of answers) with the obtained N-gain value is 0.43. The achievement of the highest indicator increase in this study occurs because the indicators identify/formulate the criteria of answers that may be at the lowest stage in critical thinking skills that is on the aspect of providing basic explanations. Critical thinking skills used by students in learning is still simple and not too complex compared to the other four indicators of critical thinking skills.

In addition, during the learning process using MBI\textsubscript{2} in progress, indicators identify or formulate possible criteria of answers, quite easily trained to learners. As an example in the discussion of the Moon phase cycles, the teacher first simulates the process of the Moon phase cycles in MBI\textsubscript{2} as shown in Figure 5.

Then the teacher asks the students to describe the phases of the moon phase along with the position of the moon on Earth in the given worksheet. Based on the results of the picture, the students are requested to identify/formulate the possible answers to the problems presented on the worksheet inquiries regarding the sequence of the phases of the moon phase. Here is an example of an answer to the student worksheet shown in Figure 6.
4. Conclusion
Utilizing MBI$_2$ can enhance the critical thinking skills Students’ on the solar system concept in the Medium category with value of N-gain $<g> = 0.61$. MBI$_2$ can serve as an alternative solution to present an interesting learning media to develop the learning motivation and critical thinking skills of students needed in the 21st century.

Acknowledgement
This work was financially supported by “Hibah Fundamental” Kementerian RISTEK DIKTI, Republik Indonesia’s Research Grants in the fiscal year 2017.

References
[1] Siahaan P, Suryani A, Kaniawati I, Suhendi E, and Samsudin A 2017 Journal of Physics: Conference Series, 812 012017
[2] Hermawan, Siahaan P, Suhendi E, and Samsudin A 2017 American Institute of Physics Conference Proceedings, 1848 050009
[3] Samsudin A, Suhandi A, Rusdiana D, and Kaniawati I 2016 Journal of Physics: Conference Series 739 012006
[4] Paul, R 1996 Critical thinking workshop handbook (Rohnert Park, CA: Centre for Critical Thinking, Sanoma State University.
[5] Ennis R H 1993 Theory Into Practice 32 179
[6] Barak Miri, Ben-Chaim David, Zoller Uri 2007 Res Sci Educ 37 353-369
[7] Popescu A and Morgan J American Association of Physics Teachers 45 507
[8] Bhakti S S, Samsudin A, Chandra D T, and Siahaan P 2017 American Institute of Physics Conference Proceedings 1848, 050012
[9] Testa I and Galano S 2015 Physical Review Special Topics-Physics Education Research 11 020102
[10] Kaniawati I, Samsudin A, Hasopa Y, Sutrisno A D and Suhendi E 2016 Journal of Physics: Conference Series 739 012060
[11] Wibowo F C et al 2016 Journal of Physics: Conference Series 739 012044
[12] Wibowo F C et al 2017 Advanced Science Letters 23
[13] Hake R R 1999 Analyzing Change/Gain Scores (Indiana: Indiana University)