The aesthetics display, program and learning features: A validation toward STEM based e-module for learning integrated science

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Abstract. The purpose of this study was to develop STEM Based e-module that is a learning software for improving secondary school students interest in STEM field. Four questions are addressed to unpack the feasibility of e-module that is used for integrated science teaching. The questions are 1) How is the aesthetic display of STEM Based e-module 2) How is the program of e-module 3) How are the learning features presented in e module 4) How are STEM aspects performed in e-module. Data were obtained by exploring the view of three experts in STEM education fields. Instrument used was a rubric consisting 29 questions and open questions about e-module strength and weakness as well as the experts recommendation. The study reveals that the aesthetics display, program, learning features and STEM aspects of e-module were categorized into excellent, fair, excellent and excellent respectively. STEM aspects presented in e-module are appropriate for secondary school STEM based teaching. This finding showed that feasibility of e-module implementation in secondary school setting is highly recommended. Nevertheless, an experimental study is necessary to validate the e-module quantitatively.

1. Introduction
Interest in the fields of science, technology, engineering and mathematics (STEM) among teens in many countries including Indonesia is now declining. An effort to repair the condition can be started from school setting. It is believed that STEM learning experience is inline with students’ interest in pursuing STEM fields in tertiary education as opposed to non-STEM fields [1]. Therefore, an effort for improving STEM in class setting will be helpful.

Several study investigating STEM in secondary school had been conducted. A questionnaire was developed to explore behaviour of learning and to investigate students’ STEM achievement [2]. An interdisciplinary STEM module has been developed to help students learn meteorology [3]. A robot-based game is used to improve students’ interest and reasoning skills [4]. Nevertheless, there has been no study developing e-module integrating science and mathematics. This study is projected to build STEM-based e modules, which includes science content (physics, chemistry, biology), technology engineering and mathematics in a single media named STEM-based e-module. This study was conducted particularly to answer four questions which are: 1) How is the aesthetics display of STEM Based e-module 2) How is the performance of e-module’s program 3) How are the learning features presented in e module 4) How are STEM aspects performed in e-module.
2. Method
This study used descriptive method to unpack the performance of STEM based e-module. A set of questionnaires consisting 29 questions and open-ended questions were proposed to three experts. The questions cover e-module’s aesthetics display, program and learning features. Ten questions were addressed to e-module’s aesthetics display. Six questions were used to explore the e-module’s program and learning features. Seven questions were addressed to explore STEM approach in the e-module. Furthermore, open ended questions were used to attain the experts’ suggestions.

Data were analysed descriptively by determining average score of each aspect. A conversion into qualitative classification were made based on criteria which are: 1) Excellent for score 4,2 and upper 2) good for score 3,4 – 4,2 3) mediocre for score 2,6 – 3,4 4) Poor for score 1,8 – 2,6 and 5) worst for score less than 1,8. Moreover, the strength and weaknesses were identified for revising the e-module. The experts’ suggestions were also considered to improve the quality of STEM-based e-module.

3. Result and discussion
This part elaborates the overall STEM-based e-module quality according to the experts. Four aspects in STEM-based e-module which are the aesthetics display, the program, learning features and STEM aspects are then discussed specifically.

3.1. The overall quality of STEM-based E-module
This study found two categories posed by STEM-based e-module. Those categories are ‘good’ and ‘mediocre’. This finding shows the high possibility for implementing the e-module in class setting. The ‘good’ category is reached by three aspects that are aesthetics display, learning features and STEM aspects. The average scores for each aspects are presented in figure 1.

Figure 1. The average score of STEM based e-module aspects.

Figure 1 shows each of the aspects reach high score that are higher than 3. The STEM-based e-module’s learning feature reach the highest score which is 4.17. The lowest score is gained by e-module’s program which is 3.33. Score of the e-module’s aesthetics display and STEM aspects are 3.53 and 4 respectively. STEM based e-module aesthetics display, learning features and STEM aspects are categorized into ‘good’. Whereas, the e-module’s program is categorized into mediocre. No one of the e-module’s aspects categorized into excellent neither worst. This finding indicates that the STEM based e-module is highly possible to be implemented within class setting through various tool. The use of this e-module can be an appropriate way to give students experiences on STEM learning. It can improve students’
interest in STEM field not only when the students are in secondary school but also when they take tertiary education because students who join STEM programs in secondary schools will be more interested in elaborating STEM at tertiary education [1].

3.2. The aesthetic display of STEM-based E-module
The aesthetic display of STEM-based e-module reach 3.53. It is categorized into good. Table 1 shows detail score of each aspect within e-module’s aesthetic display.

| Component   | Score | Category   |
|-------------|-------|------------|
| Font        | 3.67  | good       |
| Color       | 4.00  | good       |
| Graphic     | 3.33  | mediocre   |
| Animation   | 3.00  | mediocre   |
| Sound       | 3.33  | mediocre   |
| Screen      | 3.67  | good       |
| Direction   | 3.00  | mediocre   |
| Language    | 3.67  | good       |
| Characters  | 3.33  | mediocre   |
| Display     | 4.33  | excellent  |

Table 1 shows that the components of aesthetic display of STEM-based e-module reach various score which are good, mediocre and excellent. The component reaching highest score is e-module’s display, while the reaching mediocre are graphic, animation, sound, direction and character. Thus, the words, pictures and other media of the e-module fulfil the need of mental representation of science content within the module. This finding indicates that the e-module meet the demand of science multimedia learning. Multimedia learning occurs when the components construct a mental representation based on the words and pictures [5].

3.3. The learning features of STEM-based E-module
The learning features of STEM based e-module is categorized into ‘good’. The detail attainment of this aspect is shown in table 2.

| Learning feature          | Score | Category   |
|---------------------------|-------|------------|
| The selection of learning materials | 5     | Excellent  |
| The pertinence of learning theme   | 4.67  | Good       |
| The clarity of learning materials     | 3.33  | Mediocre   |
| The clarity of example          | 3.67  | Good       |
| The clarity of exercise         | 4     | Good       |
| The clarity of feedback        | 4.33  | Excellent  |
Table 3 shows that almost all of the aspects of learning features reach high score which are categorized into Excellent, good and mediocre. The selection of learning materials are categorized into excellent. The STEM-based e-module consists of physics, chemistry and biology which are integrated into a single contextual theme. This model of curriculum is named as webbed model which meets the integration of curricula within meaningful context [6].

There are three themes performed in the e-module. Those are “Oxygen for Life”, “Earth Layers” and “Environmental management”. Each theme contains physics, chemistry, biology and mathematics. For example the theme of “Earth Layers” contains physics concept, that is “Heat and Temperature”. This concept is performed in the form of animation shown in figure 2.

![Figure 2. The animation about heat and temperature.](image)

Based on figure 2, it is shown that the STEM-based e-module optimizes digital technology in science teaching and learning purpose. This fact proves that the e-module has meet the needs of technology into science teaching and learning. It meets an interdisciplinary approach within science teaching and learning. This fact indicate that this e-module performs STEM in different manner with that in meteorology context [3]. The use of theme as context in the e-module potentially supports the beneficial impact on integrated science lesson. It is in line with the use of integrative approach in STEM education which gives large effect on students’ achievement [7].

3.4. The aspects of STEM within the E-module
This study found that the STEM aspects performed in the e-module is categorized into “good”. This finding shows that the e-module can properly be used to teach STEM. However, few revisions are
needed to improve its quality. Detail description of STEM applied in the e-module is shown in table 3.

Table 3. The detail description of STEM aspects performed in e-module.

| Aspect of STEM | Score | Category |
|---------------|-------|----------|
| Mathematics   | 3.67  | Good     |
| Physics       | 4.33  | Excellent|
| Chemistry     | 3.67  | Good     |
| Biology       | 4.33  | Excellent|
| Technology    | 4.00  | Good     |
| Engineer      | 4.00  | Good     |

Table 3 shows the detail score for each aspect of STEM performed in the e-module. Excellent category is reached by two aspects which are physics and biology. Physics contents taught within the e-module are earth layers, heat and temperature and electrical charge. The example of physics content and biology content are shown in figure 3 and figure 4.

Based on figure 3 and figure 4, it is noticed that the e-module performs creative science content. The figure provides spatial-logical thinking to deliver physics and biology contents. This kind of thinking is one of requirement of creative thinking [8]. This finding implies creative infusion within the e-module which is in line with the necessity of creative manner in STEM education. STEM teaching should be presented in creative manner [9]. Another feature presented within the e-module is STEM project.
Students are asked to do project connected to STEM. This project allows students to work in team. The role of teacher in this project is to facilitate students to work collaboratively. This finding support teachers’ identity during STEM learning which are collaboration, flexibility, awareness of students needs, and advocates of equity and inclusion [10].

4. Conclusions
This study shows the high possibility of STEM-based e-module to be implemented in class setting. The ‘good’ category is reached by three aspects that are aesthetics display, learning features and STEM aspects. This finding indicates that the e-module meet the demand of science multimedia learning. The e-module’s components construct a mental representation based on the words and pictures. The use of theme as context in the e-module potentially supports the beneficial impact on integrated science lesson. Therefore, the e-module can properly be used to teach STEM. An experimental study implementing the e-module is needed for further validation.

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