Development of heat and temperature e-module based on discovery learning for secondary students

A R Najihah*, V Serevina and M Delina

Physics Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jl. Rawamangun Muka No 1. Jakarta Timur 13220, Indonesia.

*Corresponding author: aniqnajihah@yahoo.com

Abstract. Information and Communication Technology (ICT) are essential for developing countries, especially in the learning environment. Its help students to get extensive information anytime and anywhere. This research developed an ICT media (e-module) for senior high school students grade XI in heat and temperature course. The focus of this research is to provide an e-module based on discovery learning by Research and Development (R&D) Methodology with ADDIE approach. The product validation results showed that the heat and temperature e-module could be used by students to enrich their knowledge.

1. Introduction

The rapid development of Information and Communication Technology (ICT) has taken an important part in learning environment [1]. ICT has become a complementary component in the traditional face to face traditional learning [2] as well as a bridge in fostering education for special needs people [3].

Currently, the learning process in the newest Indonesian curriculum (the 2013 curriculum) focused on learning process base on ICT. It is in line with 2013 Indonesian education regulation number 69 for senior high school and Islamic high school. This 2013 curriculum was developed based on three criteria: internal, external and paradigm factor. Wherein the external factor applies ICT in the learning process [4]. Consequently, the education today cannot be detached from ICT. In the learning process, ICT play roles as an information source and learning media [5]. As the information source, ICT supplies information through computer-based learning. For example, an electronic book (e-book), powerpoint and electronic module (e-module) [6]. E-module is a teaching material which consists of video, animation, diagram, text, and quiz [7]. As a learning media, ICT helps students to get a deep understanding of the subject. Therefore, this learning media has to be interactive and flexible because it should be able to run in the various format [8].

Along with the learning media, a learning model is essential as well in the learning process [9]. A good learning model encourages students to be active [10]. One of the examples is the discovery learning model. The discovery learning is more effective than traditional face-to-face model [11], wherein teacher-center learning is changed to be the student-center learning [12, 13]. This discovery learning model encourages students to build their knowledge based on their experiences [14].

In this research, numbers of need assessment were done to gain student need information on the learning media. The need assessments were applied to student grade X, XI and XII at 17 senior high schools in Jakarta, Depok, Tangerang, and Bekasi. The assessment results show that among various media (powerpoint, video, e-book, and e-module), e-module is infrequently used in the learning process. Afterward, another data was gained from the national test score in 2016/2017 to find out the
hardest subject in physics. The data showed that heat and temperature subject was the most challenging subject. Based on the need assessment and national test score, an e-module on heat and temperature subject for grade XI at secondary school was then developed to support the learning process.

2. Methods
In this study, the research and development method was employed to develop an e-module based on discovery learning with ADDIE approach. ADDIE approach consists of five steps; analyze, design, develop, implement and evaluate. Here it was the process.

2.1 Analyze
The process was initiated with numbers of assessments need to gain student need information on the learning media. The assessments need was applied to students at 17 secondary schools in Jakarta, Depok, Bekasi, and Tangerang. Then gained another data from the national test score in 2016/2017 to find out the hardest subject in physics.

2.2 Design
The assessments need results and national test score data were adopted as the based information to fulfill the student need; an e-module which cover heat and temperature subject

2.3 Develop
The process is continued by developing an e-module.

2.4 Implement
The product (e-module) was assessed and validated by various experts; media, material, and learning expert. The assessment and validation results were used to revise the e-module product. The assessment value is conducted from the following formula.

$$P_s = \frac{n}{N} \times 100\%$$  \hspace{1cm} (1)

where $P$ is the percentage (%) of the successful test, $S$ is the score and $N$ is the maximum score. Then data (the test score) were interpreted in the following table.

| Percentage   | Interpretation     |
|--------------|--------------------|
| 0 % - 20 %   | Not very good      |
| 21 % - 40 %  | Less good          |
| 41 % - 60 %  | Enough             |
| 61 % - 80 %  | Good               |
| 81 % - 100 % | Very good          |

2.5 Evaluate
In this step, the product was evaluated by students. The product was then improved and revised based on the student evaluation. After some improvement and revision, the e-module can be accessed online in the following page http://www.aniqrifatunnajihah.com/
3. Results and Discussion

The validation results from various experts are displayed in table 2, 3 and 4. The validation result from media expert was described in the Table 2.

**Table 2. Validation result from material expert**

| No. | Aspect                      | Mean score | Interpretation |
|-----|-----------------------------|------------|----------------|
| 1.  | The content component       | 80%        | good           |
| 2.  | The language                | 90%        | very good      |
|     | Average value               | 85%        | very good      |

The validation result in table 2 showed that the average value is 85%. Based on value interpretation in table 1, this number is very good. This means the e-module are good and merit. Therefore, the validation result from media expert is shown in Table 3.

**Table 3. The validation result from media expert**

| No. | Aspect                  | Mean score | Interpretation |
|-----|-------------------------|------------|----------------|
| 1.  | E-Modul Introduction   | 85%        | very good      |
| 2.  | E-Modul component      | 84%        | very good      |
| 3.  | E-Modul characteristic  | 80%        | good           |
| 4.  | Language                | 83%        | very good      |
| 5.  | Diagram                 | 80%        | good           |
| 6.  | Display                 | 73%        | good           |
|     | Average value           | 81%        | very good      |

The validation result from media expert is 81%. It means the e-model aspects which consist of introduction, component, characteristic, language, diagram and display are very good. The validation results from a learning expert is shown in Table 4.

**Table 4. The validation results from learning expert**

| No. | Aspect                     | Mean score | Interpretation |
|-----|---------------------------|------------|----------------|
| 1.  | The feasibility of the contents | 84%       | very good      |
| 2.  | The language              | 80%        | good           |
| 3.  | Display                   | 85%        | very good      |
|     | Average value             | 83%        | very good      |

The validation result from the learning expert is 83%, which mean very good. After the media validation process, then e-model was tested in a small group student consist of 10 students at SMAN 9 in Tangerang. The result of this group test is shown in Table 5.

**Table 5. The test results in a small group student**

| No. | Aspect | Mean | Interpretation |
|-----|--------|------|----------------|
| 1.  | introduction | 86%   | very good      |
| 2.  | component  | 90%   | very good      |
| 3.  | characteristic | 89%   | very good      |
| 4.  | The language | 95%   | very good      |
| 5.  | Diagram    | 90%   | very good      |
| 6.  | Display    | 91%   | very good      |
|     | Average value | 90%   | very good      |
Based on several aspects: introduction, component, characteristic, language, diagram, and display, the test result is 90% which mean very good. The Figure 1-6 show the preview of e-module.

Figure 1. The preview of the e-module cover

Figure 2. The diagram of orientation and hypotheses page

Figure 3. The literature preview

Figure 4. The picture of the conclusion part

Figure 5. An example of formative test results

Figure 6. The display of formative test review
4. Conclusion

According to validation results from the material, media and learning expertise, as well as the student test, the heat and transfer e-model is proper and very good to be used as the learning the material for senior high school student grade XI.

References

[1] Mihai A 2009 *Eur J Open Distance E-Learn* 1
[2] Getuno D M, Kiboss J K, Changeiywo J M and Ogola L B 2015 *J Educ Pract* 6 80
[3] Aksal F A and Gazi Z A 2015 *TOJET* 14 70
[4] Kemendikbud. Permendikbud N0. 69 tentang kerangka dasar dan struktur kurikulum Sekolah Menengah Atas (SMA) atau Madrasah Aliyah (MA). Jakarta: Kementerian Pendidikan dan Kebudayaan, 2013.
[5] Jaffer S, Ng’ambi D and Czerniewicz L 2007 *IJEICT* 3 131
[6] Woo T K 2011 *AAOU J* 6 53
[7] Nugent G, Kohmetscher A, Namuth-Covert D, Guretzky J, Murphy P and Lee D 2016 *Interdiscip J e-Ski Life Long Learn* 12 113
[8] Lee Y C 2008 *Comput Educ* 50 1423
[9] Quinton S and Smallbone T 2010 *J Innov Educ Teach Int* 47 125
[10] Ames C 1992 *J Educ Psychol* 84 261
[11] Tran T 2014 *Int J Learn Teach Educ Res* 7 44
[12] Joolingen V W 1998 *Int J Artif Intell Educ* 10 385
[13] Skeen T and Zafonte M 2015 *J Instr Res* 4 69
[14] Anderson R D 2017 *J Sci Teach Educ* 13 1