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STEM Education - based E-Module for Hearing Impaired Students

Muhammad Nur Hudha^{1,2 *}, Dyah Triwahyuningtyas¹, Sudi Dul Aji¹, Ana Rafikayati³, Alim Sumarno⁴, Isma Widiaty², Asep Bayu Dani Nandiyanto², Anna Permanasari², Ida Hamidah² and Ade Gafar Abdullah²

¹Universitas Kanjuruhan Malang, Jl. S. Supriadi no 48, Malang 65148, Indonesia

²Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi 229, Bandung 40154, Indonesia

³Universitas PGRI Adi Buana Surabaya, Jl. Dukuh Menanggal XII, Surabaya 60234, Indonesia

⁴Universitas Negeri Surabaya, Jl. Rektorat Unesa, Lidah Wetan, Surabaya, 60213, Indonesia

Abstract-STEM education is undoubtedly important to be applied along with the development of technology in nowadays context. However, STEM-based learning has not been optimally developed by using E-module, especially to teach students with disabilities. The study was conducted by applying Four-D research design which includes **Define, Design, Develop, and Disseminate**. The data were collected through interview, questionnaire, and validity of product of development data collection instruments. Further, the data were analyzed by using descriptive data quantitative and qualitative analysis. The study involved teachers, special education subject lecturer, learning media subject lecturer, and a number of hearing impaired students in Malang city. The result of E-module development towards hearing impaired students is proven valid by the study.

Keywords: STEM-based, Four-D, Disseminate.

Introduction

Studies on Science, Technology Engineering and Mathematics (STEM) have rapidly developed [1]. STEM learning deals with practice and structure that are able to influence students learning outcome [2]; therefore, STEM approach is widely applied in classroom learning since it has become an important factor that contributes to learning and education development [3].

STEM education and learning combine four aspects that cover science, technology, engineering, and Mathematics as a unit that is intertwined one to another [4]. The STEM education aims to make students have adequate science and technology knowledge from reading, writing, observing, doing science experiment, and to make students be able to solve their daily problems dealing with STEM education [5]. The STEM education includes 4C in its learning activities that cover creativity, critical thinking, collaboration and communication [6]. STEM learning activities are also conducted by considering several other aspects, namely observation, new ideas, innovation, creativity, and society [7]. This approach of education has been massively conducted in the classroom learning and the results show that the application of STEM education in the learning process gives positive contribution in improving students' academic and non academic competences [8]. Accordingly, the application of STEM education is highly recommended to be carried out to young learners and it is suitable to be applied in learning activities at primary schools level.

The STEM education may be further improved through several steps, one of them is by developing module [9][10]. However, STEM learning development through electronic module (E-Module) hasn't been widely developed. In fact, STEM based e-module is needed to support learning process of students with disabilities, especially hearing impaired students that makes the STEM based E-module is crucial to be developed.

Hearing impaired students have some difficulties in communication when the learning focuses on abstract aspects. Learning media that is suitable for hearing impaired students tends to be in the form of interactive module [11][12]. Through interactive module, the students are eased to understand what are articulated by the animation and/or the video after they have been struggling to read mouth movements of their teachers in their daily learning process [12]. Besides, the condition of facilities, for example qualified laboratory with advanced and modern tools, that are different between regions, or even those are unavailable in some regions [13], make interactive module is important to be developed and used in the learning process of hearing impaired students.

Departing from this point of view, the current study is aimed to develop one learning media, STEM based E-module to improve learning efficiency of students with disabilities, in this case hearing impaired students. It is expected that the E-module can ease students to understand the STEM materials that may lead to their more efficient learning. If the

*Corresponding Author: Muhammad Nur Hudha, Email: muhammadnurhudha@unikama.ac.id

module isn't developed, it is assumed that students with disabilities or hearing impaired students will face more difficulties in comprehending STEM materials, including Science or Math.

Methods

The study was set as a Research and Development design. The development model that was applied by the current study employed following steps, namely Define, Design, Develop, and Disseminate (Four-D) [14][15][16]. This study was designed only until Develop step, by conducting validation test towards the product, in this case E-module.

The study was carried out by previously analyzing needs, curriculum, and hearing impaired students, as a subject of the study. After that, a starting draft in developing e-module was made and then validation test on the product was designed and developed. Further description of E-Module development procedure can be seen in Figure 1.

a) Definestep

In this step, some analysis on needs, curriculum, and students with disabilities was determined and defined as a prerequisite of the learning. Each description of analysis are as followed.

1. Need analysis: this analysis was made to get a clear description on the real condition of the field of the study (need assessment), to further find basic problems relating to the e-module development.
2. Curriculum analysis: the analysis was conducted to note the coverage of standard competence and basic competence, concepts included in the standard competence and basic competence, and learning tasks given to achieve the determined standard competence and basic competence.
3. Students analysis: this step was designed to define the characteristics of the students that include level of students' thinking skills. This analysis is needed to be used as a basic reference of the e-module development.

b) Designstep

In this step, a first draft of e-module development was made based on the analysis that have been previously conducted, need analysis, curriculum analysis, and student analysis.

c) Developstep

Through this step, the study started to develop the e-module product. This step includes the product validation to some experts that is intended to get inputs on the whole aspects of the materials included in the e-module that is being developed. When the e-module hasn't been considered valid, it was then revised. Once the e-module has been considered valid, a validation test was done to know the practicality or the usage of the e-module that has been developed. The development step, therefore, covers validity test, practicality test, and effectiveness test. The e-module is developed by using flash application/software. A comprehensive description of e-module development procedure can be seen in the following figure (Figure 1).

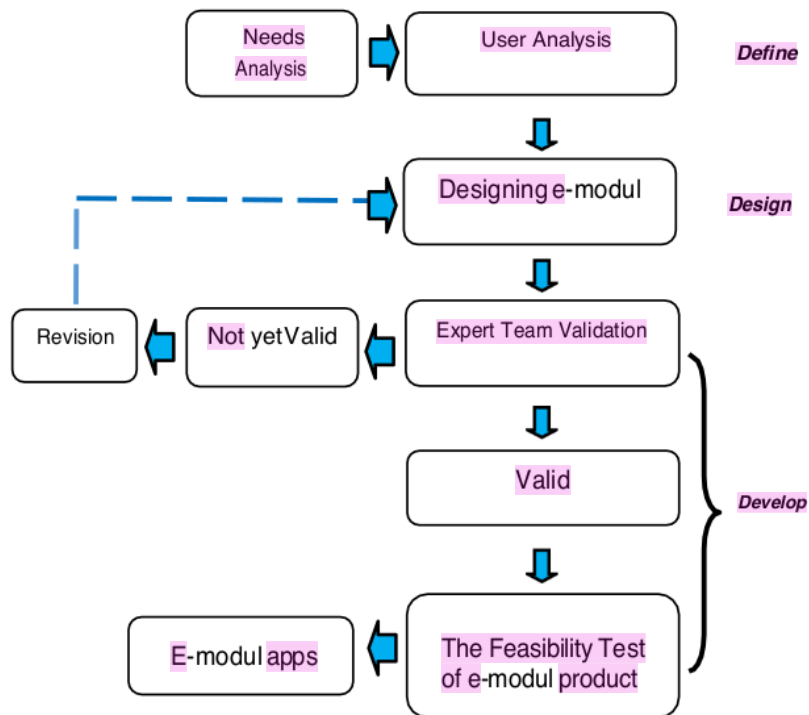


Figure 1. E-Modul Development Procedures

The study of e-module development involved teachers, special education subject lecturers, and learning media subject lecturers. The data were collected by using two data collection instruments, namely interview and questionnaire on the validity of the product developed. The data gained by the study are quantitative and qualitative data. Quantitative data were collected through questionnaire, observation, and learning material product. Meanwhile, qualitative data were gained through in depth interview with lecturers and teachers involved in the study. The data gained were then analyzed qualitatively and quantitatively. The data collected from validity test from the experts were analyzed to get the percentage and were then explained qualitatively. The topic that is included as learning material in the e-module for hearing impaired students is change of form of subject in the primary school level.

Results and Discussion

The development of e-module on the change of subjects' form has been adjusted to level of materials on students with disabilities, in this case students with hearing impairment. The analysis of level of materials in developing e-module is unavoidably needed. This is conducted by adjusting the materials to the students' condition, curriculum used in the school, and the field condition [17]. This kind of adjustment is related to the combination of some basic competences from different semesters and combination of students' skills.

There is sign language in every item presented in this application. The level of sign language usage is demonstrated by experienced parties, in this case lecturers and experts in special education. The flowchart of the development is presented in Figure 2 below.

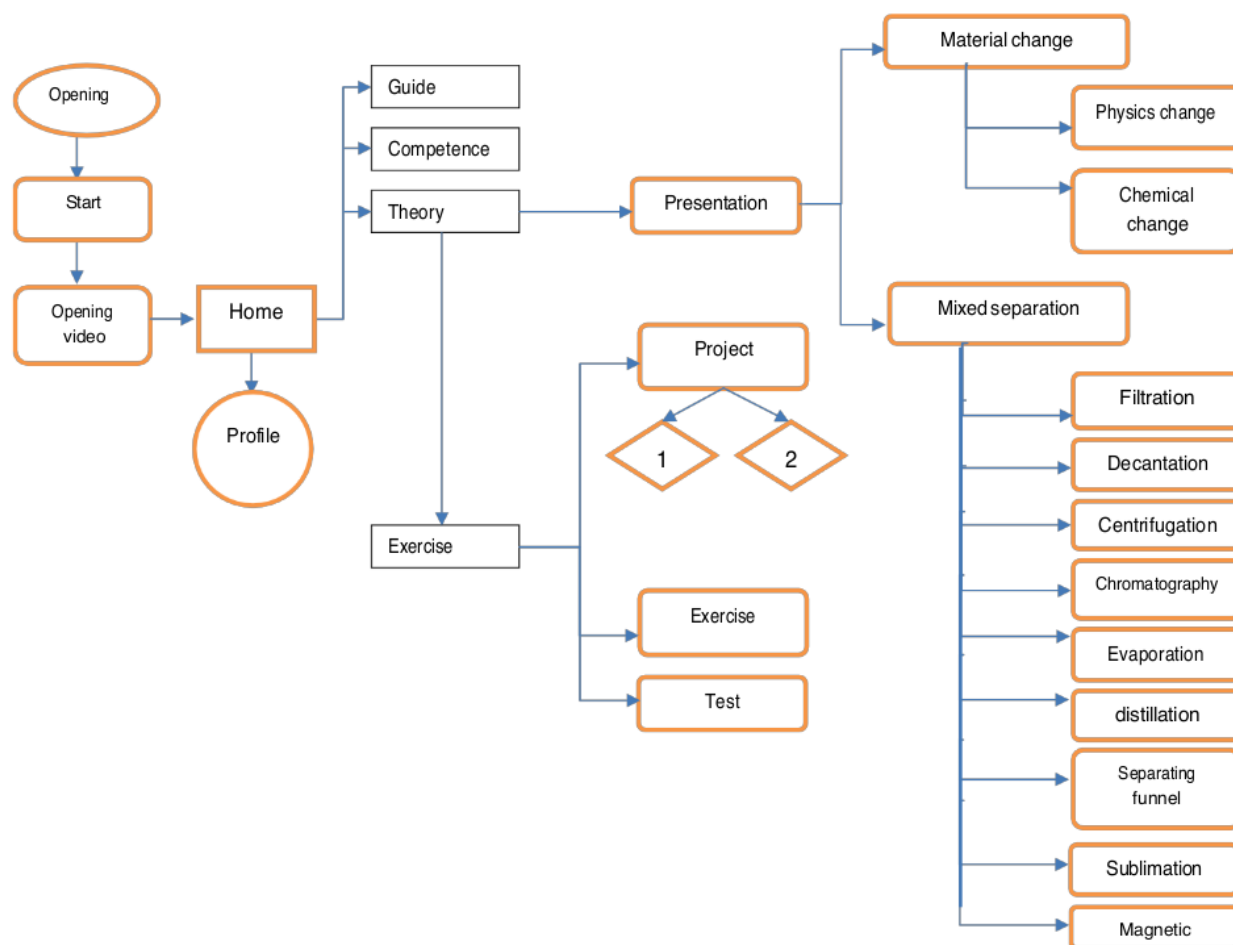


Figure 2. E-module Development Flowchart

The developed e-module consists of opening video that leads to students' problem. In every problem given, students are also shown a discussion relating to the problem and exercise to be solved. After that, there will be some relating materials and presentation materials that need to be accomplished by the students. Along with that, information on competence, directions to use, and also exercises, as well as examination and projects are also presented in the e-module. E-module has several benefits, one of them is easiness in notifying students' learning progress since the e-module enables teachers and even students to click print their learning outcome whenever they have accomplished learning tasks, discussions, or tests in the e-module application. In other words, students are enabled to check their learning progress by using this application. Once the students are enabled to check their own learning, they play active role in the learning process by being actively engaged in cognitive, affective, meta-cognitive aspects as well as in improving learning motivation [18].

After designing e-module, the next step is conducting validity test. Validity test was conducted to the experts and was intended to know whether the application or the e-module that has been developed valid to be used in the learning process or not[15]. Data of validity test of the e-module were gained from experts on technology of learning media, content experts, and language experts. The data collected are quantitative and qualitative data where the quantitative data are used to test the validity of the product developed, meanwhile the qualitative data are used to give suggestions to revise the e-module[20]. The results of components analysis on e-module validity gained from the experts is presented in the following table (Table 1). This instrument is adapted from some previous related studies [21][22].

Table 1. Results of Component Analysis of E-module Validity

No.	Component	Percentage	Criterion
1.	Learning media technology validity	90 %	Very valid
2.	Content validity	84 %	Valid
3.	Language use validity	88 %	Valid

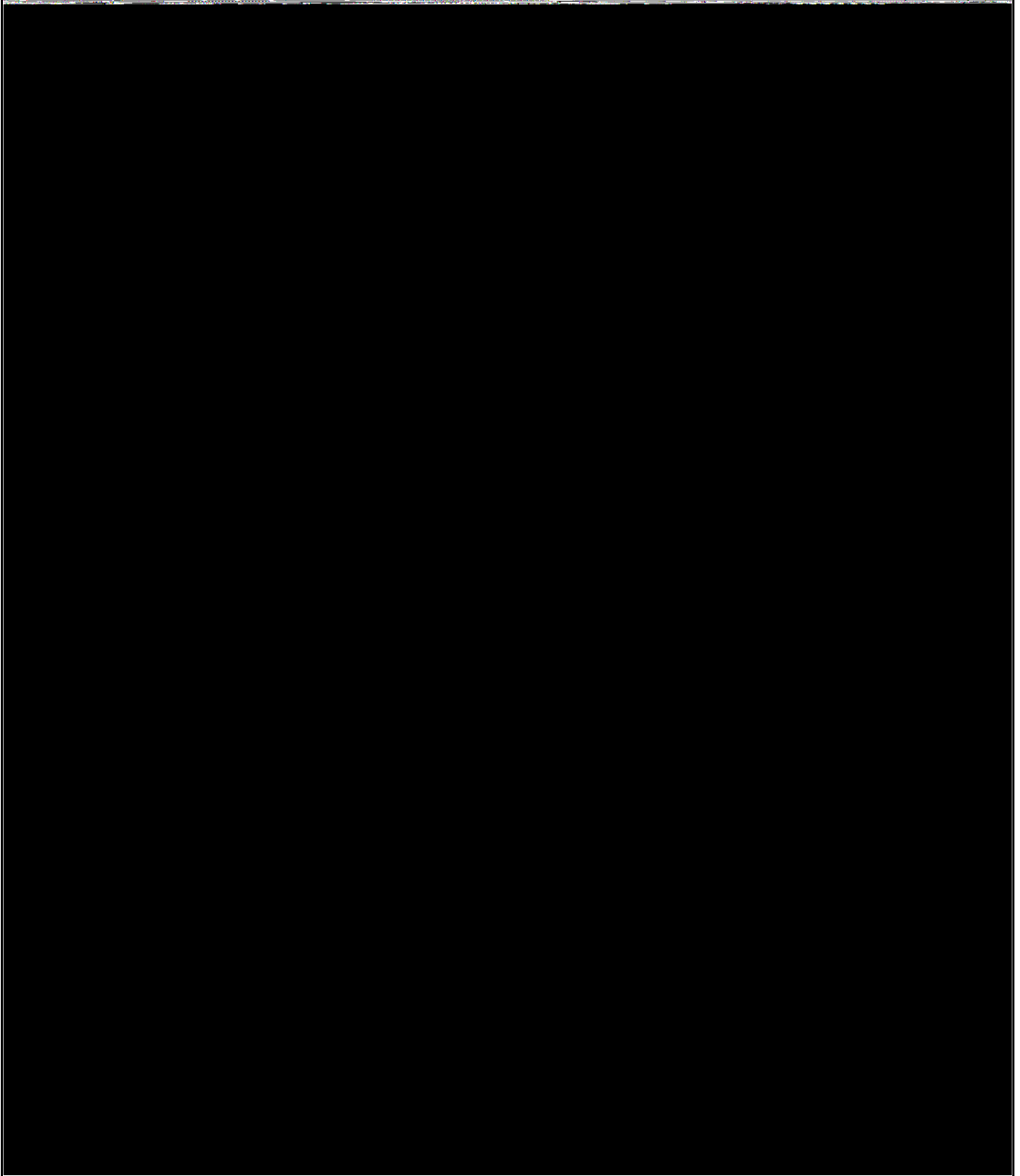
Based on the results of quantitative and qualitative analysis, it can be concluded that e-module on change of subjects' form topic to students with hearing impairment has been considered valid. The validity of the product's learning media technology validity is 90%, content validity 84%, and language use validity 88%.

Some suggestions are also given from the experts saying that the presentation or position of sign language should be more adjusted to the structure of the e-module so that the students will be more eased to access the content. In addition, the content should be also made to meet the level of learning development of students with disabilities. This is due to students' characteristics that are different from students in other regular or formal schools [23].

Another suggestion is also addressed to the teachers when they are suggested to keep focusing on pedagogical objectives, not only on innovation and technology aspects[24] which means that the use of e-module should be under teachers' control. Further, teachers also recommended to work collaboratively to share ideas, discuss students' problems to be next solved by using and applying innovative STEM educational methods[25]for students with disabilities.

Conclusion

STEM education for hearing impaired students needs to be implemented from now. A technological touch is needed to make students with disabilities understand and comprehend the learning materials easier; one of which is by providing them with interactive electronic modules. E-module is able to provide students with interactive animation and sim-



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