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Designing and Developing an Electronic Module based Science, Technology, Engineering, Arts and Mathematic on Biology Learning

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Abstract. The aims of this study was to design and develop an electronic module based science, technology, engineering, arts and mathematic on biology learning. Design 4-D (define, design, develop and disseminate) was conduct to develop the product in biology learning. Data was collected by validation and practicality worksheet. Data was collected also analysis by descriptive statistics. The result of the study was show that electronic module based science, technology, engineering, arts and mathematic on biology learning was valid (83,85%) and practice (80,28%). This result indicate that this electronic module has been developed with reference to the principles of research and development. The results of this study also show that the electronic module based science, technology, engineering, arts and mathematic characteristics are owned by the modules that have been developed. In conclusion, electronic module based science, technology, engineering, arts and mathematic on biology learning was valid and practice.

INTRODUCTION

21st century learning challenges educators to prepare students for biology learning [1, 2, 3]. 21st century learning requires humans to have technology and information management skills, learn and innovate, have a career and have global awareness, and have character. For this reason, learning is needed that supports the needs needed by students, especially prospective teacher students.

Learning that is considered appropriate to provide 21st century skills is STEAM. STEAM builds on existing interdisciplinary curriculum models [4]. The results of another study explain that the analysis of the STEAM learning concept from the literature provides three sub-constructs in the prospects – the STEAM movement, the goals of STEAM education, and the benefits of STEAM education [5]. The main thrust of STEAM education comes from twenty-first century skills for the job market and future economy with the ethical use of natural and other available resources. This explanation shows that STEAM is used in learning that has been described and reported in other articles [6, 7, 8, 9, 10].

In March 2020, learning patterns were implemented from home due to the spread of the coronavirus, including the University moving a large part of their operations to homework, with profound implications for students, academics and professional services staff [11]. Online learning is highly recommended, including a holistic approach towards the use of integrated online management and delivery systems [12], especially to keep students equipping students with 21st Century skills [13]. For this reason, learning media are needed that facilitate learning such as electronic

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modules. Modules are often used in learning as they have been used in problem-based learning [14] and the Broadnet Project learning [15].

The research objective was to design and develop an electronic module in biology learning. The module is designed using respiratory system materials with the characteristics of e-modules based on science, technology, engineering, arts and mathematics. The selection of STEAM characteristics on the prototype is considered important because STEAM is considered capable of promoting creativity and student learning diversity [16]. Although computer-based learning media have been developed before [17], STEAM is considered capable of increasing student engagement, and has the potential to increase student learning activities [18]. STEAM is also an interactive approach used in Interdisciplinary to Transdisciplinary learning [19, 20, 21].

METHOD

This study uses Research and Development [22]. The development stages are defining, design, develop and disseminate. At the define stage, an analysis of the development needs has been carried out. The instrument used is an interview guide to ask educators and students. At the design stage, activities are carried out to design a module framework that is adapted to the characteristics of the development. At the develop stage, validation is carried out by the validator team on the prototype that has been designed. The prototype assessment is carried out by the validator using an assessment instrument with didactic, construct, technical and linguistic indicators. Revision of the prototype is carried out based on the advice of the assessor. To test the goodness of the prototype, a practicality test was carried out by a small group of users (biology teachers and students). This stage is carried out to obtain information about whether the developed electronic module is easy to use in the learning process. The data obtained were analyzed using qualitative descriptive statistics.

RESULTS AND DISCUSSION

The results of the define phase showed that (a) pilot schools used the 2013 curriculum; (b) The teacher uses the learning media used are power points and digital teaching materials and (c) Students have various abilities. The results of the research at the design stage, an e-module prototype based on science, technology, engineering, arts and mathematics, has the characteristics of; (a) the opening section contains the cover, inner cover, preface, table of contents; (b) the introduction section, contains background, brief description of the module, benefits/relevance, core competencies, basic competencies, learning objectives, instructions for using modules, concept maps; (c) the content section, contains the learning activities section consisting of indicators of competency achievement (GPA), subject matter, material descriptions, examples and illustrations, summaries, assignments/practices, self-tests and (d) the final section contains: evaluation section, key answers, feedback, glossary, bibliography, cover. The results of the validation test are written in **Table I**. The results of the practicality test are written in **Table II** and **Table III**.

TABLE I. E-module validation results based on science, technology, engineering, arts and mathematics

No	Aspect	Validator (s)			Total	High Score	%	Category
		1	2	3				
1.	Didactic	31	27	35	93	108	86,11	Very valid
2.	Construct	95	86	106	287	336	85,41	Very valid
3.	Technique	21	16	20	57	72	79,16	Valid
4.	Language	15	15	16	46	60	76,66	Valid
	Total	162	144	179	483	576	83,85	Very valid

TABLE II. The results of the practicality test of e-modules based on science, technology, engineering, arts and mathematics by the teacher

No	Aspecty	Score	High Score	%	Category
1.	Ease of use	23	28	82,14%	Very practice
2.	Learning time efficiency	10	12	83,33	Very practice
3.	Benefit	27	28	96,42	Very practice
	Total	60	68	88,23	Very practice

TABLE III. The results of the practicality test of e-modules based on science, technology, engineering, arts and mathematics by students

No	Aspect	Score	High Score	%	Category
1.	Ease of use	451	552	81,70%	Very practice
2.	Learning time efficiency	219	276	79,34%	practice
3.	Benefit	438	552	79,34%	practice
	Total	1.108	1.380	80,28	practice

The results of this study show that the product that has been designed is valid. A validity of a product can be measured using an instrument in the form of a questionnaire. In designing a product validation questionnaire, the author adapts to the principles of writing and compiling the questionnaire, namely the questionnaire format, the language used, and the questionnaire statement items. To determine whether the instrument that has been designed is valid and can be used to measure the level of product validity in the form of an e-module, the author also validates the instrument, namely from the aspect of the questionnaire format, the language used, and the questionnaire statement items. The product validation instrument validation carried out by 3 validators was very valid with an average of 93.05%. The assessment for the questionnaire format is very valid with a percentage of 100%. The assessment for the language used is very valid with a percentage of 91.66%. The assessment for the questionnaire questions is very valid with a percentage of 91.66%. Therefore, the product validation instrument is declared to be very valid and can be used to measure the level of product validity.

Based on the validation of e-modules based on science, technology, engineering, arts and mathematics by 3 expert validators, consisting of 2 biology lecturers, and 1 class XI biology teacher. Validation results with very valid criteria with an average percentage of 83.85%. The validations carried out in this study were on didactic requirements, construct requirements, technical requirements, and linguistic requirements. In accordance with the results of the validator's research on didactic requirements, it is known that the development of e-modules obtained an average of 86.11% and was declared very valid in accordance with the 2013 curriculum, e-modules can invite students to be active and independent in the learning process, e-modules provide emphasis on the process of finding concepts, e-modules can be used for individual and group learning, e-modules can help students understand the material of the coordination system, these e-modules are designed according to the characteristics of students, and with this e-module make the learning process more effective.

The completed e-module based on science, technology, engineering, arts and mathematics is used by biology teachers and high school students in class XI MIPA, and can be used as an example for teachers and prospective teachers in developing teaching materials such as electronic modules (e-modules). which directs students to solve problems by utilizing the power of technology [23]. Learning media is valid if it is developed using adequate theory, it is called content validity. All components of the learning product, which are related to each other consistently, are called construct validity. The indicators used to conclude that the learning product developed is very valid, namely content validity and construct validity [24].

The practicality of a product can also be measured using instruments in the form of questionnaires and by means of interviews. in this practicality test used practicality questionnaires for teachers, interview sheets for teachers, and practicality questionnaires for students. In designing a practical questionnaire, the author adjusted to the principles of writing and compiling the questionnaire, namely the format of the questionnaire, the language used, the items of the questionnaire statement. To determine whether the instrument that has been designed is valid and can be used to measure the level of practicality of the product in the form of an e-module, the author also validates the instrument consisting of aspects of the questionnaire format, the dangers used, and questionnaire statement items.

Validation of practicality instruments for teachers in the form of a questionnaire conducted by 3 validators is very valid with an average of 84.72%. The assessment for the questionnaire format is very valid with a percentage of 91.66%. The assessment for the language used is very valid with a percentage of 83.33%. The assessment for the questionnaire items is very valid with a percentage of 83.33%. Therefore, for the validation of the practicality instrument for teachers, it is stated to be very valid and can be used to measure the level of practicality of the product for teachers. Validation of practicality instruments in the form of interview sheets for teachers conducted by 3 validators is valid with an average of 77.77%. The assessment for the interview format is valid with a percentage of 75%. The assessment for the language used is valid with a percentage of 75%. The assessment for the interview question items is valid with a percentage of 80.55%. Therefore, for the validation of the practicality instrument for teachers, it is declared valid and can be used to measure the level of practicality of the product for teachers.

Validation of practicality instruments for students carried out by 3 validators is very valid with an average of 84.72%. The assessment for the questionnaire format is very valid with a percentage of 91.66%. The assessment for

the language used is very valid with a percentage of 83.33%. The assessment for the questionnaire items is very valid with a percentage of 83.33%. Therefore, for the validation of the practicality instrument for students it is stated that it is very valid and can be used to measure the level of practicality of the product for students.

The practical results of e-modules based on science, technology, engineering, arts and mathematics by biology subject teachers are very practical, with a percentage of 88.23%. The first aspect of the instrument item assessment is ease of use, the assessment on the ease of use aspect is very practical with a percentage of 82.14%. The second aspect of the assessment is the efficiency of learning time, the assessment of the efficiency of learning time is very practical with a percentage of 83.33%. The third aspect of the assessment is the benefit, the assessment of the benefits is very practical with a percentage of 96.42%.

In addition to using a questionnaire to test the practicality of the e-module, the author also conducted interviews with teachers. From the results of these interviews, it can be seen that this e-module is very interesting, the material presented is very complex and clear so that it can motivate students in learning. This e-module can assist teachers in delivering material to students and can make students active in learning. This e-module can make students think critically in the learning process. In addition to the coordination system material, it can also be used in other learning materials. From the practicality test using either a questionnaire or an interview, it can be concluded that this e-module is very practical to use.

The practical results of e-modules based on science, technology, engineering, arts and mathematics by students are practical, with a percentage of 80.28%. The practicality test by students was carried out by 23 students, the aspects of the assessment consisted of ease of use, time efficiency, and benefits. The results of this study are in line with research that has been carried out by previous research which shows that the sub-constructions under the priority of STEAM education are – curriculum integration in STEAM education and STEAM as curriculum reform [6]. The findings of this study show that there are educational and research implications of developing STEAM-based modules. STEAM education has significant implications for future education in general, and science education in particular' [21]. The results of this study are in line with other findings which explain that the use of ICT and modules in biology learning has been rated as good by college students [25-26].

CONCLUSION

The results of the validation of e-modules based on science, technology, engineering, arts and mathematics are 83.85% with very valid percentage criteria. E-modules can invite students to be active and independent in the learning process, e-modules emphasize the process of finding concepts, e-modules can be used for individual and group learning, e-modules can help students understand the coordination system material, this e-module is designed according to the characteristics of students, and with this e-module it makes the learning process more effective.

The practical results of e-modules based on science, technology, engineering, arts and mathematics by biology subject teachers are very practical, with a percentage of 88.23%. The practical results of e-modules based on science, technology, engineering, arts and mathematics by students are practical, with a percentage of 80.28%. From the results of these interviews, it can be seen that this e-module is very interesting, the material presented is very complex and clear so that it can motivate students in learning.

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