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The Development of Digital Teaching Materials: An Effort to Create Mathematics Learning Effectively at Universitas Muhammadiyah Sumatera Utara in the New Normal Era

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Abstract

The process of learning conducted by lecturers in higher education currently obliges the student learning activities which are derived from the student centered learning (SCL) approach. This active learning must also be integrated with website-based IT information technology. Internet-based learning is a learning model that uses internet and web-based technology in accessing learning materials and allows learning interactions between fellow students or with lecturers anywhere and anytime. On this origin, this research intends to develop digital teaching materials that can be accessed by students at any time because they are integrated with Android. This research uses development research (r&d) methods. In this research, the phases taken are: 1) designing digital teaching materials, validating design experts and material experts. The outcomes proved that the design for developing internet-based teaching materials was carried out in three phases, that is the needs analysis phase (PDP UMSU 2020), the design phase, and the development and implementation phase. In the design phase, expert validation is carried out. The outcomes of the validation of the material content experts are in good qualification (88%), the outcomes of the validation of the learning design experts are in good qualifications (80%). Thus, it can be concluded that internet-based teaching materials are effective for improving student learning outcomes at the Fakultas Keguruan dan Ilmu Pendidikan (FKIP) UMSU during the new normal period after the Covid 19 pandemic.

Keywords
teaching materials; validation; FKIP UMSU

I. Introduction

It is an absolute thing to do in all educational institutions, especially in higher education trough online learning during the Covid-19 Pandemic. Sihombing and Nasib (2020) stated that the Covid-19 pandemic caused everyone to behave beyond normal limits as usual. Ningrum et al (2020) stated that the impact caused by this virus also approached Indonesia and its entire region. Absolutely the facilities and infrastructure, as well as infrastructure that support the optimal online learning need to be improved periodically. Additionally, the competence of lecturers in innovating technology-based learning must continue to be improved. One of the forms is the transfer of teaching materials to digital forms that are mobile so that students can use them.

The developing learning tools activity in the courses taught by lecturers in universities is very essential to improve the quality of the process and student learning outcomes. In addition to teaching materials, one type of learning device in this digital era is a learning application that can be accessed via Android. Realizing the importance of this, we cannot rule out the process of making learning applications, but must be more

serious in pursuing and working on making learning applications with a high sense of responsibility and dedication. An essential issue that is often experienced by the lecturers in learning activities is choosing or determining appropriate learning materials or teaching materials in order to help students achieve competence. This is due to the fact that in the curriculum or lesson plans, teaching materials are only written in outline in the form of subject matter. It is the task of the lecturer to describe the subject matter so that it becomes a complete teaching material. In addition, how to use teaching materials is also a problem. The intended use is how to teach it from the lecturer's point of view and how to learn it from the student's perspective.

In connection with the teaching materials selection, the problems that are generally faced include determining the type of material, depth, scope, order of presentation, treatment (treatment) of learning materials, and choosing the source where the teaching materials are obtained. There is a tendency that the source of teaching materials is focused on books. Though there are many sources of teaching materials other than books that can be used. Books don't have to be of the same type and don't have to change frequently as has happened so far. Various books can be selected as a source of teaching materials. The development of course teaching materials cannot be separated from the curriculum development sequence of the study program. Teaching material products as far as possible refer to the competencies and needs of graduate users. Teaching materials, whether in written form or not, should be arranged systematically so as to create an environment/atmosphere that allows the learning process to occur.

The learning tools development, such as teaching materials and learning applications by lecturers can also be used as a reference for the measure of the lecturer's professionalism. This refers to the Assessment of Credit Scores for Functional Positions and Lecturer Ranks. In the assessment of the Credit Score, the innovative development of substantial teaching materials in the form of books, modules, dictates, instruction modules, models, aids and so on is one of the assessment items that must be met by lecturers.

Several research outcomes which related to the development of digital teaching materials have been published in many international and/or national journals. Some of them are Ratiyani (2016:79) The effectiveness of learning through the development of digital teaching materials has a huge impact on learning activities. Through research conducted by Ratiyani, an increase in learning activities occurs in the learning process that she does. The increase in learning activities after using digital teaching materials with the application of the 5E cycle learning model (Learning cycle 5E) was 71.18% at the first meeting and 79.51% at the second meeting.

The outcomes of the 2020 research (Beginner Lecturer Research Scheme) conducted by the researchers provide recommendations that further research is needed in the form of developing digital-based teaching materials that can be accessed on devices in application format. Therefore, furthermore, this year researchers are trying to develop digital teaching materials that can be used as a means of supporting independent learning for FKIP UMSU students in the current new normal era. Research is carried out through stages or procedures: (1) preliminary or exploratory studies (previously it has been done); (2) initial product development (prototype) of digital teaching materials by utilizing the android operating system, and (3) validation tests by material experts and design experts.

The formulation of the problem in this study is as follows. (1) How is the process of developing digital teaching materials in the PGSD FKIP UMSU Study Program? and (2) How is the feasibility of the outcomes of developing digital teaching materials in the PGSD FKIP UMSU Study Program?

Derived from the formulation of the problems mentioned above, the objectives of this study can be formulated as follows. (1) Develop digital teaching materials in the PGSD FKIP UMSU Study Program. (2) Testing the feasibility of digital teaching materials developed in the PGSD Study Program.

II. Review of Literature

2.1 Learning in the Web-Based Digital Era (E-Learning)

The rapid development of information and communication technology has encouraged various educational institutions to utilize e-learning systems to increase the effectiveness and flexibility of learning. Although many research outcomes prove that the effectiveness of learning using e-learning systems tends to be the same when compared to conventional or classical learning, the advantages that can be obtained with e-learning are in terms of flexibility. Through e-learning, learning materials can be accessed anytime and from anywhere. In addition, materials that can be enriched with various learning resources including multimedia can be quickly updated by the teacher.

In its development, this e-learning system is used by most educational institutions in the world. Overseas such as in the United States, e-learning has been used almost 90% at every level of education units that have more than 10,000 students. (Basori, 2013:2). Because of the benefits that are so felt, there are various kinds of e-learning development models. Starting from just a power point based in class, to the LMS system (Learning Management System). There are many types of LMS used today, one of which is Schoology. Schoology is one of the LMS in the form of a social web that offers learning the same as in the classroom for free (free) and easy to use like social media Facebook.

Due to the relatively new development of e-learning, the definition and implementation of e-learning systems varies greatly. This is due, among others, to the absence of a standard pattern in the implementation of e-learning, limited human resources, both developers and teaching staff in e-learning, limited hardware and software, limited costs and development time. As for the actual teaching and learning process, especially in countries with very slow internet connections, the use of the e-learning system can be combined with conventional learning systems known as blended learning or hybrid learning systems.

2.2 Development of Digital Learning Applications

Teaching materials are a set of learning tools or tools that contain learning materials, methods, limitations, and evaluation methods that are designed systematically and attractively in order to achieve the expected goals, that is achieving competence or sub competence with all its complexity, while according to Lestari (2013: 1) teaching materials must be designed and written with instructional rules because they will be used by lecturers to assist and support the learning process. Learning materials or materials are basically the contents of the curriculum, that is in the form of subjects or fields of study with topics/subtopics and details (Ruhimat 2011:152).

Teaching materials are prepared by looking at the various goals to be achieved in the curriculum that is being used which is then realized through learning in the classroom. According to Majid (2005:15), teaching materials are prepared with several objectives. The objectives are as follows: 1) helping students in learning something. 2) Providing various types of choice of teaching materials. 3) Facilitating teachers in carrying out learning. 4.) Creating learning activities becomes interesting.

There are various forms of books, both used for schools and universities, for example reference books, teaching modules, practicum books, teaching materials, and textbooks. These types of books are certainly used to make it easier for students to understand the teaching materials in them. According to Lestari (2008: 49), in accordance with the writing issued by the Directorate General of Primary and Secondary Education of the Ministry of National Education in 2003, teaching materials have several characteristics, that is self-instructional, self-contained, stand-alone, adaptive, and user friendly.

The steps for making learning media in the form of an android application as Setiadi (2018) explains can be taken in several steps, that is: 1) compiling media/flowcharts, 2) making applications using Adobe Animate CC software, 3) publishing in the form of e-mail. apk which can later be installed on android smartphones, and 4) The testing phase on smartphones can be run using the debugging process on smartphone devices, in this research the testing phase uses a Samsung Galaxy J5 smartphone with CPU specifications: QuadCore, 1.2GHz Display: Super AMOLED, 720 x 1280 (HD), Camera Resolution: CMOS 13.0 MP, Android Version 4.4 Kitkat.

The various features so that e-books created as Liesaputra and Witten (2012) describe can match or even exceed printed books, that is by having various navigation features in e-books such as automatic search, page turning, virtual location markers, bookmarks and annotations. In addition, it is possible to combine various advantages of the digital environment such as hyperlinks (direct links), multimedia, automatic identification of synonyms, cross-references of key terms with online encyclopedias, and can automatically create indexes at the end of books. The communicative multimedia is a dynamic technology that obliges certain input from the user to convey a set of information through text, graphics, images, or video. Usually interactive multimedia applications are designed to display specific outcomes and provide feedback quickly. Like interactive multimedia, interactive ebooks are combined media, that is a way to produce and deliver material by combining several forms of media such as text, images, audio-video, animation, etc. which are controlled by a computer (Arsyad, 2011).

The accumulation of interactive multimedia into e-books must meet several requirements in order to produce effective and meaningful learning. Learning software developers must know the principles in designing learning multimedia. Mayer (2009) revealed several principles that must be met in the development of multimedia, that is: 1) the multimedia principle, 2) the spatial proximity principle, 3) the time proximity principle, 4) the coherence principle, 5) the modality principle of, 6) the redundancy principle, and 7) the individual difference principle of. As an addition mastering the basic principles of making learning multimedia, multimedia developers must consider the quality criteria of multimedia produced before use.

Thorn (1995) suggests six criteria that must be met in evaluating interactive multimedia. The first is ease of use and navigation. A program needs to be designed as simple as possible so that students have no difficulty in understanding the language used. Second, the cognitive load where users need to master the content, structure, and workings of the program well. The program must be intuitive so that it will work as intended by the author. The third is the scope of knowledge and presentation of information. The fourth is media integration where multimedia needs to be combined to produce meaningful learning. The fifth is the aesthetic aspect which is intended to attract students' interest. The last one is the overall function. The program developed must be able to provide learning as expected by students. That is, when finished using the program, students will feel they have learned something.

III. Research Methods

Research and development (R & D) is used for applying this research. The design of this development is Research and Development. The development in question is in the form of developing digital teaching materials as a learning supplement in the new normal era at FKIP UMSU. The selection of this model is derived from the consideration that this model is to produce a learning media product because this model focuses on product development to be made and evaluations carried out at each phase. Hannafin & Peck is a teaching design consisting of three phases, that is 1) the needs analysis phase (already done), 2) the design phase, and 3) the development and implementation phase as Wiyani (2013) states.

Phase I Needs Analysis (needs assess), in this phase it is necessary to identify the needs in developing a learning media including the objectives and objects of the learning media created, the knowledge and skills obliged by the target group, equipment and learning media needs.

Phase II Design. In this phase, transfer the information obtained from the analysis phase into the form of a document that will be the purpose of the developed media, one of the documents produced is a storyboard document.

Phase III Development and Implementation. In this development phase, you create a product derived from a previously created storyboard. The activities carried out are flow chart production, testing, and evaluation of learning outcomes. The storyboard document will be used as the basis for making flowcharts that can help the process of making learning media. While Implementation is applied to determine the effectiveness of the product that has been developed.

The assessment in the Hannafin & Peck model is carried out continuously at each phase. There are two types of evaluation that can be carried out, including assignments and post tests. Assignments are carried out throughout the media development process such as expert test validation, individual, small group, and field trials, while post test evaluation is carried out after the media has been developed to determine the effectiveness of the products that have been developed. The three development phases can be seen in the development chart as follows.

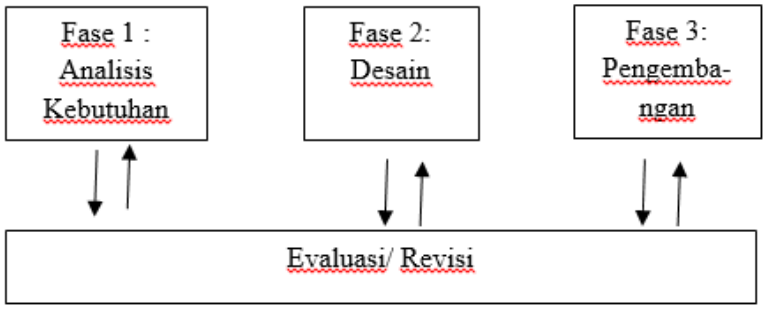

Figure 1. *Hannafin & Peck development model (Source: Novan Ardy Wiyani, 2013: 45)*

In the research reported in this article, the research was only carried out in phase 2, because phase 1 has been carried out on the 2019 UMSU PDP, while phase 3 is planned to be carried out in 2021 PDP UMSU funding. This development research uses three types of data collection methods. The three methods are: observation, interviews, and special tests. Data on the suitability of learning materials and designs on products were obtained from material experts and design experts through expert validation tests. The expert validation data is used to determine the feasibility of the outcoming product. Data on the

attractiveness, convenience, and usefulness of the product were obtained from field tests conducted directly on students.

IV. Results and Discussion

4.1 Digital Teaching Material Development Process

After the digital teaching materials are produced, the next step is before this product is disseminated to a wide audience, it is necessary to carry out a validation test by media experts and material experts / The outcomes of validation and assessment by material experts and media experts on each aspect of the overall assessment are determined by the average score of their respective criteria. The outcomes of the assessment are analyzed to determine whether or not it is appropriate for application-based teaching materials that can be used on Android. The average percentage of the outcomes of the assessment by material experts, media experts, lecturers' assessments, as well as the outcomes of individual trials, small group trials and limited field group trials assessed derived from assessment aspects and indicators. The outcomes of the aspects of the assessment obtained will be described as follows.

a. Material Expert Validation Outcomes Data

The product validation is intended to determine the opinion of material experts regarding the feasibility of content, presentation feasibility, and language. This validation was carried out by Nur Afifah, S.Pd., M.Pd. who is a lecturer at the Muhammadiyah University of North Sumatra. The assessment was carried out to obtain information on the quality of the content of teaching materials developed to improve the quality of learning in the Elementary School Teacher at Prodi Pendidikan guru Sekolah Dasar FKIP UMSU. Derived from the outcomes of the assessment of the feasibility aspect of the material content in the developed teaching materials, it is stated that it is very good with an average total percentage of 85.29%. The data from the material expert validation on the feasibility of the content can be seen in table 1 below.

Table 1. Expert Assessment of Digital Teaching Materials

Sub Component	Indicator	Average (%)	Criteria
A. The suitability of the material with learning outcomes	1) Completeness of materials	87.5	very good
	2) Material breadth	87.5	very good
	3) Material depth	87.5	very good
B. Material Accuracy	1) Concept and definition accuracy	75	very good
	2) Accuracy of facts and data	100	very good
	3) Sample and case accuracy	87,5	very good
	4) Accuracy of drawings, diagrams and illustrations	87,5	very good
	5) Accuracy of terms	87.5	very good
	6) Notation, symbol and icon accuracy simbol	87.5	very good
	7) Reference accuracy	75	very good
C. Material Update	1) The suitability of the material with the development of science	87.5	very good
	2) Presenting material relevant to the current development of literary theory	100	very good
	3) There is a learning video	87,5	very good
	4) Using case examples found in everyday life	75	very good

	5) Library updates	75	very good
D. Arouse curiosity Curiosity	1) arouse curiosity	87.5	very good
	2) Creating the ability to ask questions	75	very good
average		88	very good

The outcomes of the validation by the validator above on the feasibility of the content indicate that the feasibility of the content of the learning media that has been developed includes very good criteria. The presentation feasibility assessment according to the material expert is considered very good with a total average percentage of 88%. Assessment of language aspects according to material experts is considered very good with a total average percentage of 87.50%. The data from the material expert validation on the language aspect can be seen in table 2.

Table 2. Expert Assessment of Digital Teaching Materials

Sub Component	**Indicator**	**Average (%)**	**Criteria**
A. straightforward	1. Correct sentence structure	87.5	very good
	2. Sentence effectiveness	87.5	very good
	3. Term standard	75	good
B. Communicative	1. Message readability	87.5	very good
	2. Accuracy of language use	87.5	very good
C. Dialogic and interactive	1. Ability to motivate messages or information	87,5	very good
	2. Ability to encourage critical thinking	87,5	very good
D. Conformity to the level of development of students	1. The suitability of the intellectual development of students	87.5	very good
	2. Conformity with the level of emotional development of students	100	very good
E. Coherence and coherence of the flow of thought	1. Coherence and integration between learning activities	87,5	very good
	2. Coherence and coherence between paragraphs	87,5	very good
F. Use of terms, symbols and icons	1. Consistency of use of terms	87.5	very good
	2. consistency of use of symbols or icons	87.5	very good
average		**91.35**	very good

b. Learning Media Expert Validation Outcomes Data

Learning media design experts validate teaching material products on the aspects of learning media/information technology developed. This validation was carried out by Eko Febri Syahputera Siregar who is a lecturer at the Universitas Muhammadiyah Sumatera Utara whose expertise is relevant to the integration of the internet in the learning process. The assessment on the media aspect is carried out to improve the display quality of the developed digital teaching materials. The outcomes of the validation of learning media by learning media experts concluded that the learning media developed were in very good criteria with a total average percentage of 85%. The data from media expert validation can be seen in the table below.

Table 3. Assessment Scores of Design Experts on Digital Teaching Materials

Sub Component	Indicator	Average (%)	Criteria
A. Learning Media Cover Design (Cover)	1. The appearance of the layout elements on the front, back and back covers harmoniously has rhythm and unity and is consistent.	87,5	very good
	2. Displays a good center point.	87,5	very good
	3. The colors of the layout elements are harmonious and clarify the function.	87,5	very good
	4. The composition and size of the layout elements (title, author, illustration, logo, etc.) are proportional, balanced, and in tune with the layout of the content (according to the pattern).	87,5	very good
	The font used is attractive and easy to read.		
	1. The size of the title of the instructional media is more dominant and proportional than the size of the instructional media, the name of the author.	87,5	very good
	2. The color of the instructional media title contrasts with the background color.	87,5	very good
	3. Do not use too many typeface combinations.	87,5	very good
	Illustration of learning media cover		
	1. Describe the content/teaching material and reveal the character of the object.	75	good
	2. Shape, color, size, proportion of objects according to reality.	87,5	very good
C. Learning Media Content Design	Layout Consistency		
	1. Consistent placement of layout elements based on patterns	87,5	very good
	2. The separation between paragraphs is clear	87,5	very good
	Harmonious Layout Elements		
	3. Printable area and proportional margin	87,5	very good
	4. The margins of two adjoining pages are proportional	75	good
	5. The space between the text and the illustration is appropriate	87,5	very good
	Complete Layout Elements		
	6. Placement of learning activity titles, learning activity subtitles, and correct page/folio numbers	75	very good
	7. Placement of illustrations and image captions (caption) is correct	87,5	very good
	Layout Speed Up Pages		
	8. Placement of decoration/illustration as a background does not interfere with the title, text, page numbers.	87,5	very good
	9. The placement of titles, subtitles, illustrations, and image captions does not interfere with understanding.	87,5	very good

	Typography Simple learning media content		
	10. Don't use too many fonts.	100	very good
	11. The use of letter variations (bold, italic, all capital, small capital) is not excessive.	87,5	very good
	12. Normal text array width.	87,5	very good
	13. Spacing between lines of normal text arrangement.	87,5	very good
	14. The spacing between letters (kerning) is normal.	87,5	very good
	Typography Learning media content Facilitates Understanding		
	15. The hierarchy of titles is clear, consistent and proportional	87,5	very good
	16. Sign of cutting words (hyphenation).	75	good
	Content Illustration		
	17. Able to reveal the meaning of the object.	75	good
	18. Accurate and proportional shape according to reality.	87,5	very good
	19. Creative and dynamic	87,5	very good
average		**86,25**	very good

Note: Several suggestions from the design expert validators, both written and verbal, are generally listed in table 3.

Some suggestions from media expert validators are as follows.

1. The adjustment to the guidelines for writing learning media.
2. The cover must be adjusted to the substance of the material presented in the learning media
3. The icons usage must be adjusted to the cognitive development of students.
4. Paying attention to the positioning of the subtitles

The design experts considered that the digital teaching materials developed for students were already feasible with an average score percentage of 85%. The average percentage outcomes were obtained derived from the assessment sub-components in the form of the size of the instructional media, the cover design of the instructional media, and the design of the content of the instructional media.

V. Conclusion

Derived from the formulation of the problem, the outcomes of data analysis and discussion in this study, the following conclusions can be drawn. (2) The design for the development of digital teaching materials consists of three phases that is the needs analysis phase, the design phase, and the development and implementation phase. In the design phase, expert validation is carried out. The outcomes of the validation of material content experts are in good qualifications (88%), the outcomes of the validation of learning design experts are in good qualifications (80%), the evaluation outcomes of learning media experts are in good qualifications (85%). The next stage is the implementation of the learning model by testing the effectiveness of the learning model. Consequently, it can be concluded that the digital teaching materials produced in this study deserve to be tested to see the effectiveness of these teaching materials if they are disseminated to the students.

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