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Validity and Practicality Test of Applied Mathematics Digital Teaching Materials for Blended Learning for Polytechnic Engineering Students

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ABSTRACT

This study aims to determine the level of validity and practicality of teaching materials in textbooks, and digital Student Activity Sheets (SAS) applied mathematics for blended learning. Research using the 4D model development method includes: Define, Design, Develop, and Disseminate, carried out in the engineering sector of the Politeknik Negeri Bali (PNB). The validity of textbooks and SAS is seen from the feasibility of content, presentation, language and graphics. Simultaneously, practicality is seen from the ease of use, the attractiveness of offerings and benefits. Data were collected through validation and practicality questionnaires, then analyzed descriptively. The results showed that the validity of textbooks and SAS reached 83.1%, and 83.7% were categorized as valid, while the practicality level reached 83.4% and 82.9% were valid categories. Applied mathematics digital teaching materials are suitable for blended learning, but minor revisions are needed. The implication is that Draft II of applied mathematics digital teaching materials, its development after minor revisions can be continued to the effectiveness test, evaluation and dissemination stages.

INTRODUCTION

The 21st century is based on science and technology, so it demands a country's human resources to master various skills. Higher education institutions must prepare quality graduates who can compete globally and master technological developments (Iswan & Herwina, 2018). Polytechnic as a Vocational College is moving quickly in taking advantage of opportunities and challenges in the era of the industrial revolution 4.0 to produce competent, skilled and superior human resources following the needs of the business world and industry in the future. One form is utilizing ICT in the learning process, such as e-learning. This step is a concrete manifestation to increase the achievement of 21st-century competence. However, lecturers and students' responses about using e-learning, especially at the Bali State Polytechnic, are not likely to be optimal.

The Covid-19 pandemic emerged in early 2020, forcing every face-to-face activity to stop, including learning activities in higher education. Learning in the era of the industrial revolution 4.0 and during the Covid 19 pandemic must make the learning process take place continuously without space and time limits; learning is held through e-learning (Firman, & Rahayu, 2020). All stakeholders must prepare all e-learning tools (Kemendikbud, 2020). Lecturers are required to innovate to change face-to-face learning patterns into full online learning patterns through e-learning.

E-learning provides benefits for both lecturers and students (Singh, O'donoghue, & Worton, 2005). E-learning has a level of effectiveness at least the same as face-to-face learning (Nguyen, 2015). On the other hand, fully online learning is considered unable to accommodate all learning needs (Tuncay et al. l., 2011), one of which is the difference in each student's learning styles. The e-learning method will be more efficient when mixed with face-to-face learning (Hameed, Badii, & Cullen, 2008). To complement each other between e-learning and face-to-face learning, a Blended Learning model can be used. Blended learning can be a solution to overcome e-learning pursuit's weaknesses (Noer, 2010; Husamah, 2014). Combining the advantages of face-to-face learning models and digital-based learning models will positively affect the learning process. (Lin, Tseng, & Chiang, 2017; Lopes & Soares, 2018).

Blended learning is proven to be effective in improving the quality of learning outcomes: it positively impacts students' academic achievement at Jordan (Obiedat et al. l, 2014). Proven effective in assisting students to learn English grammar (Isti'anah, 2017). Blended learning has also been shown to positively impact learning outcomes for skills and attitudes (Almasaeid, 2014) and can improve students' understanding (Bibi & Jati, 2015). The prerequisite for the learning device for blended learning has been well prepared by the teacher (Abdullah, 2018).

Teaching materials as learning resources need to be adapted to students' conditions and the learning strategies used by the lecturers. Learning in the future leads to using a blended learning model (Darma, Karma, and Santiana, 2020). Carman (2005) states that there are five keys to success using blended learning to improve the quality of learning, namely: live events, self-paced learning, collaboration, assessment, and performance support materials. Performance support materials are tools and performance support materials, one of which is learning materials. Learning materials are prepared in digital form. These study materials must be accessible to students both offline and online.

Teaching materials are means or learning tools containing materials, methods, limitations, and ways of evaluating learning that are designed systematically and attractively to achieve the expected goals. According to Majid and Rochman (2015), teaching materials are information, tools and texts needed by the teacher or instructor for planning and studying the implementation of learning. These include textbooks, modules, Student Activity Sheets (SAS), handouts, and others. Two interrelated teaching materials that are widely used in education are textbooks and SAS.

Textbooks are handbooks for a course written and compiled by experts in related fields, comply with textbook rules, and are officially published and disseminated (Kemendikbud, 2017). According to characteristics and plans for student learning activities, textbooks are prepared based

on special provisions related to learning to meet needs, according to characteristics, and plans for student learning activities. Its position and function are critical in learning activities (Muslich, 2010).

SAS is a printed teaching material in the form of sheets containing assignments that refer to basic competencies, complete with instructions or work steps so that students can study independently or assisted by lecturers. In line with Prastowo (2015) and Trianto (2011), SAS is a teaching material that has been packaged so that students are expected to learn the teaching material independently. One of its functions is to minimize the role of lecturers and activate students more (Trianto, 2012).

To improve the quality of applied mathematics learning through blended learning, it is necessary to develop teaching materials in digital packaging. In web-based learning, digital teaching materials are independent teaching materials packaged electronically for students to learn independently. In blended learning and digital textbooks, in the learning process, students also make use of digital activity sheets (Idris, 2011).

Textbooks and digital SAS must be developed based on instructional principles to be suitable teaching materials. Several instructional principles must be considered are principles; relevance, consistency, and adequacy (Depdiknas, 2006, Akbar, 2013). Suitable teaching materials are appropriate, practical and effective teaching materials used to support the learning process activities. Triyanto (2007) states that teaching materials are said to be good if they meet: 1) validity aspects, (2) practicality aspects, and 3) effectiveness. Furthermore, Rochmad (2012) states that the development results' teaching materials are said to be valid if they meet the content validity and construct validity. Practicality refers to the degree to which users consider an intervention to be used and preferable under normal conditions (Van den Akker, 1999; 2005). Meanwhile, effectiveness is the level or degree of application of teaching materials (Rochmad, 2012).

So far, no teaching material is following the learning paradigm demanded by the 21st-century education paradigm. Teaching lecturers are guided by handouts based on conventional curricula even though learning is carried out by e-learning. On the other hand, teaching materials play an important role in every education system (Widodo & Jasmadi, 2008; Syamsul & Kusrianto, 2009; Prastowo, 2015; Jago Nulis Team, 2016; Utama, 2014). The use of appropriate teaching materials in the learning process can increase student activity in learning (Prastowo, 2015). Sidiq and Najuah (2020) proved that digital teaching materials in interactive e-modules based on Android are effectively used to improve student learning outcomes in the learning process. The use and empowerment of teaching materials in textbooks and digital SAS formats to support blended learning is necessary to improve mastery of the material for both lecturers and students (Kemendikbud, 2017).

Teaching materials and blended learning play a vital role in supporting the development of education so that when the two are combined, it can be believed that they will be able to educate students to live in the digital era. Development research is carried out to obtain suitable teaching materials per instructional principles for blended learning. Its development uses the 4D model (Define, Design. Develop, and Disseminate), which Thiagarajan developed in 1974 (Trianto,

2011). It has been implemented for three stages: the first stage was carried out in 2019, having received a draft I prototype of textbooks and digital SAS. The second stage (2020) aims to determine the level of validity and practicality of draft I textbooks and applied mathematics digital SAS for the blended learning model.

METHODS

This research aims to obtain digital teaching materials in textbooks and SAS applied mathematics for blended learning. They are conducted in the field of Engineering at the Bali State Polytechnic for three years. The subjects are Mathematics lecturers and students in the engineering field of the Bali State Polytechnic. The approach using the 4-D model includes the following stages: 1) Define, 2) Design, 3) Develop, and 4) Disseminate (Trianto, 2011). The 4D model is one of the systematic learning design models. It is more appropriate to be used as a basis for developing learning tools, not for developing learning systems (Trianyato, 2011; Arywiantari et al. l, 2015). As a systematic learning design, the 4D model is programmed with a systematic sequence of activities to solve learning problems related to a learning resource tailored to the learner's needs and characteristics.

Define needs analysis to determine objectives and problems as a benchmark in the preparation of teaching materials. Design prepares a prototype of teaching materials and evaluation tools based on the defined stage (Nieveen, 2009). At this stage, construct a test based on criteria, select suitable media, select suitable format, and determine the initial design draft prototype I of textbooks and digital SAS.

The development stage is to get a prototype of draft II of textbooks and SAS, which is valid, practical and effective. This stage is carried out through 1) expert appraisal, 2) revision, and 3) developmental testing (Nieveen, 1999; 2009). Currently only done up to the validity test stage and practicality testing through trials. Meanwhile, the effectiveness test will be carried out in the subsequent development stage in the third year. The assessment was carried out by filling out a validation questionnaire on draft I's design aspects (Akbar, 2013; Sugiyono, 2013). Meanwhile, the dissemination stage is the use of products that have been developed on a broader scale, such as classes and other lecturers. The goal is to test the effectiveness and evaluation of textbooks and SAS.

Data for validity and practicality were collected using a validated questionnaire and practicality. Validation involves content experts, media experts and practitioners. Measurement aspects include content, presentation, language, and graphic feasibility (BNSP, 2009; Depdiknas, 2008). Practicality is through small group trials, large groups and limited trials. Measurement aspects include ease of use, the presentation's attractiveness, and benefits (Nieveen, 1999; 2009). The validation questionnaire was filled in by material experts, media experts, and practitioners. Simultaneously, the practicality package is filled with lecturers and students who have different abilities (Akbar, 2013). Data validation results by expert validators and practitioners use a formula developed by Akbar (2013).

$V_{ah} = \frac{T_{Se}}{T_{Sh}} x100\%$; $V_{pr} = \frac{T_{Se}}{T_{Sh}} x100\%$ and $V_g = \frac{T_{ah} + T_{pr}}{2}$ x 100% ; where V_g = Validation (combined); V_{ah} = Expert validation; V_{pr} = practitioner validation; T_{se} = Total empirical score achieved T_{sh} = Total expected score. The criteria for interpreting the results of validation by experts and practitioners are as follows.

If 85.01% <V ≤ 100% is very valid or practical, it can be used, but it needs a small revision; 70.01% <V ≤ 85.00% valid or practical, can be used but needs a small revision; 50.01% <V ≤ 70.00% less, valid or practical, can be used but needs major revision; and 0.01% <V ≤ 50.00% is not valid or practical, should not be used (Akbar, 2013).

RESULTS AND DISCUSSION

This research is development research using the 4-D model, carried out multi-years for three years. The first stage of this year (2019) needs analysis, namely defining and designing. Has obtained the prototype I draft of textbooks and digital applied mathematics LKM. The description is as follows.

Prototype of draft I textbooks and SAS digital applied mathematics for blended learning refers to the 2014 KKNI curriculum, divided into two textbooks and SAS. Its structure: Introduction page, Nas page (torso), and completion page. The introduction page consists of a title page, a table of contents, a list of figures, a list of tables, an introduction, an introduction and a discourse. The nas (torso) page contains a detailed description of each chapter, and examples, practice questions accompany the sections. At the end of each chapter, a summary is provided to make it easier for the reader to remember important points. The facilitator page consists of attachments, a bibliography, a directory (index), and glossaries. While the SAS structure; Title, table of contents, study instructions, course learning outcomes, achievement indicators, supporting information, assignments or work steps and evaluation. (Prastowo, 2015). The type is SAS to help students apply and integrate the various concepts that have been found. The learning approach uses problem-based learning.

Teaching materials are packaged into textbooks and Applied Mathematics I and II LKM. Textbook and SAS I material, including Algebra, Geometry, and Trigonometry. Textbook material and SAS II include limit, differential and integral. The selection of material is based on relevance, consistency, and adequacy (Widodo and Jasmadi, 2008; Noviarni, 2014). The depth refers to the aspects of the course learning outcomes and learning sub-attainments, while the structure of the material content is based on a hierarchical approach (Depdiknas, 2006; Widodo and Jasmadi, 2008). Both are formatted using Flip PDF and integrated into the Learning Management System (LMS) Schoology model. Audio and video tutorials are inserted in some parts. The delivery approach uses problem-based learning. Learning evaluation uses a test form packaged in a competency test at the end of each chapter.

The 2nd stage development is currently being carried out, including expert validation and testing of the draft I to get draft II. Expert validation involves experts: 1) content (V_{ah1}), media (V_{ah2}), design V_{ah3}); and 2) practitioners (V_{pr}) (Neeeven, 1999; 2009; Akbar, 2013). Practitioners from

the teaching staff of senior mathematics teaching in engineering. The recapitulation of the results of the assessment by each validator is presented in the following table.

Aspect	Percentage Average Validity of experts and experts combined (%)			
	Textbook	Category	SAS	Category
Content (%)	83.6	valid, with small revision	85.7	very valid
Presentation (%)	84.2	valid, with small revision	85.2	very valid
Language (%)	83.5	valid, with small revision	83.5	valid, with small revision
Graphics (%)	81.3	valid, with small revision	78.8	valid, with small revision
Mean (%)	83.1	valid, with small revision	83.7	valid, with small revision

Table 1: Recapitulation of the results of validation of experts and practitioners on Textbooks and SAS Digital Applied Mathematics for Blended Learning
Data analysis phase II, 2020 [source]

Based on table 1, the achievement of validity measurement results for textbooks is the average percentage of eligibility: material content 83.6% (valid), presentation 84.2% (valid), language 83.5% (valid), and graphics 81.3% . While SAS have the average percentage of eligibility: content of the material is 85.7% (very valid), presentation is 85.2% (very valid), language is 83.5% (valid), and graphics are 78.8% (valid). The combined validity of textbooks and SAS reached 83.1% and 83.7%; both categories are valid. Both teaching materials have high content and construct validity (Van den Akker, 1999; Rochman, 2012). In terms of content: 1) learning outcomes; sub learning outcomes; Theory; exercises; reference; sources for scientific studies; and the reading material follows the curriculum and blended learning model. It has been proven that the textbooks developed refer to the curriculum and learning models developed based on strong theoretical rationale, following predetermined designs.

Meanwhile, terms of the constructs of the various components of textbooks and SAS, such as flow, structure, arrangement, have been sequential and systematic. Title, Subject learning outcomes(SLO), training materials, and ratings have been consistently linked with one another. Internal consistency between the components has been met. This content is supported by Nieveen (1999; 2009), which states that the validity aspect can be seen from: the curriculum or learning model developed and (2) the various components of the learning device are consistently related to one another. Textbooks and applied mathematics digital SAS are suitable for teaching materials in blended learning, but minor revisions need to be made according to input from the validator so that the two teaching materials become more meaningful and systematic.

Some inputs from the validator were related to content: synchronizing the sub learning outcomes and assessment indicators. In connection with the presentation, the exercises at the end of each chapter are more focused on practising problem-solving skills. Concerning language: pay more attention to using language more effectively and efficiently. Meanwhile, it relates to graphics: image layout and colouring.

Considering the suggestions given by each validator and practitioner, prototype draft I was revised to become prototype draft II, then carried out a practicality test. The practicality test was carried

out through the small group test, large group test and limited test. A summary of the practicality test results is presented in the following table.

Aspect	Percentage of Average Practicality of Lecturers (%)			
	Textbook	Category	SAS	Category
Ease of use (%)	84.5	Practical with minor revisions	81.9	Practical with minor revisions
The attractiveness of the dish (%)	81.3	Practical with minor revisions	82.0	Practical with minor revisions
Benefits (%)	82.7	Practical with minor revisions	83.2	Practical with minor revisions
Mean (%)	82.7	Practical with minor revisions	82.4	Practical with minor revisions

Table 2: Recapitulation of the practicality of textbooks and digital SAS for applied mathematics for blended learning by lecturers.
Data analysis phase II, 2020 [source]

Teaching materials	Aspect	Group Testing			Mean (%)	Category
		K_1	K_2	K_3		
Textbook	Ease of use (%)	83.3	85.6	84.2	84.4	Practical with minor revisions
	The attractiveness of the dish (%)	83.3	73.3	80.5	80.5	Practical with minor revisions
	Benefits (%)	80.0	85.2	86.8	84.0	Practical with minor revisions
	Mean (%)	81.9	82.8	85.4	83.4	Practical with minor revisions
SAS	Ease of use (%)	83.3	85.6	84.2	84.4	Practical with minor revisions
	The attractiveness of the dish (%)	80.6	75.6	86.1	80.7	Practical with minor revisions
	Benefits (%)	79.1	83.6	85.3	82.7	Practical with minor revisions
	Mean (%)	8.4	82.3	84.0	82.9	Practical with minor revisions

Note: K_1 = small group; K_2 = large group; K_3 = Limited test

Table 3: Recapitulation of the practicality of SAS Digital Applied Mathematics for Blended Learning by Students.
Data analysis phase II, 2020 [source]

The lecturer's practicality test was carried out by field testing on five lecturers and other potential users outside the Politeknik Negeri Bali engineering field. Practicality testing aspects include ease of use, the attractiveness of offerings, and benefits. The test results by lecturers and other users of textbooks in the ease of use aspect reached an average percentage of 84.5% in the practical category, the attractiveness of the presentation reached an average percentage of 81.3% in the practical category, the benefits reached an average percentage of 82.7% practical. For SAS, the ease of use aspect reaches an average percentage of 81.9% in the practical category. The presentation's attractiveness reaches a percentage of 82.0% in the practical category, and the benefits reach an average percentage of 83.2% in the practical category.

The results of the practicality test by students on textbooks in the ease of use aspect reached an average percentage of 84.4% in the practical category, the attractiveness of the presentation reached an average percentage of 80.5% in the practical category, and the benefit aspect reached an average percentage of 84.0% for the category practical. For SAS, the ease of use aspect reached an average percentage of 84.4% in the practical category, the attractiveness of the presentation reached an average percentage of 80.7% in the practical category, and the benefit aspect reached an average percentage of 82.7% in the practical category

The testing results by lecturers and other users of textbooks obtained an average practicality value of 82.7% in the practical category with small revisions. For SAS, an average practical value was obtained of 82.4%. Students' results on textbooks obtained an average practical value of 83.4% in the practical category with a small revision, while for SAS, an average practical value was obtained of 82.9. % practical category with minor revisions. The textbooks and SAS developed have met a product's practical requirements and can be used as teaching materials for blended learning after minor revisions are made, especially those related to graphics.

Blended learning applied mathematics is implemented using the Schoology application. Textbooks and SAS are uploaded to the website www. schoology.com and integrated into the resource menu. Both teaching materials are formatted using Flip PDF, inserted with audio, video tutorials that explain a real problem to enrich the student learning experience, can be stored and read in electronic communication storage (smartphone). Students can access it via the www site. Schoology so that it can be carried anywhere can be read and studied anywhere without a special room. Textbooks and digital SAS can not only be used for e-learning but can also be used for offline learning. Students do not have to meet face to face; lecturers only need to share specific links with students. Students can save it automatically on their devices. They only need to learn independently, following the learning instructions made by the lecturer. They can also reflect on learning and can have deeper discussions when they meet on a limited basis. The application of these two developed digital teaching materials does not require an internet connection. Textbooks and SAS practical digital applied mathematics are used for blended learning, but minor revisions are still needed so that the material being studied by students becomes more meaningful and systematic. The implication, after revision, prototype draft II, can be continued to the effectiveness test and dissemination at the next development stage in 2021.

CONCLUSION

The validity of the Textbook and SAS digital applied mathematics reached 83.1%, and 83.7% were categorized as valid while the practicality was 83.4% and 82.9% were categorized as practical. Both are feasible and practical for blended learning, but minor revisions need to be made, especially concerning graphics. The implication is that the prototype draft II after revision can be continued to the next development stage, namely the effectiveness test and dissemination. It is recommended that the free trial of textbooks and SAS is not limited to being carried out only at the Politeknik Negeri Bali and in similar fields at other Polytechnics.

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