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Developing Vocation Based Mathematics *E-Module* in Linear Program Material

I Wayan Sumandya
IKIP PGRI Bali, Denpasar, Indonesia

I Wayan Eka Mahendra
IKIP PGRI Bali, Denpasar, Indonesia

***Abstract*---**Vocation based Mathematics E-module is a modification from conventional module by elaborating the information technology utilization and vocation which was chosen by the students, it made this module become more interesting and interactive. This research aimed at obtaining high quality of e-module mathematics based on vocation from the side of validity, practical and affectivity. This used design research method with type research of developing which consist of three stages, i.e. *preliminary research*, *prototyping* and *assessment*. In stage of preliminary research, the data of needs analysis and material analysis. Prototyping stage was developing the product based on needs analysis and curriculum analysis. Assessment was assessing the product through expert validation, limited test and field test. The techniques used for collecting data was documentation, interview, questionnaires and test. Subject of this research was students of XI SMK in Badung Regency. According to the result of analysis, this research have successfully developed e-module of mathematics based on vocation in linear program material for XI class of Vocational School.
***Keywords*---**assessment, e-module, mathematics, prototyping, vocational school.

Introduction

Apparently, people are entering modernization era, where it has meaning as changing process of people from traditional or pre-modern community into modern community (Geria *et al.*, 2018). The transformation from less developed condition to better condition by expecting life quality improvement of society. In recent modernization period, human being is depended on technology (Kuusimäki *et al.*, 2019). It makes technology become the primary needs for every person. The needs of technology also supported by rapid science and technology development. Technology is developing quickly and continuously until nowadays. It is proved by the innovations and simple to modern inventions, including mathematics education field (Verschaffel, 2019).

Mathematics is one of essential subjects, since it is dominant in developing science and technology (Andriani, 2019). It is taught for student from elementary to middle school level (Sumandya, 2019a). Mathematics is a subject which can pursue students to be able to develop their creativity emphasized on way of problem solving (Qin *et al.*, 2014). It has

***Corresponding author**: Mahendra, I.W.E. Email: eka_undiksha@yahoo.com*
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branches such as algebra, geometry, arithmetic and analysis (Rohaeti *et al.,* 2019). The subject that commonly solved the problem, it makes students used to thing mathematically or logic, rational and critical (Suarsana *et al.,* 2018; Wartawan, 2017; Reina, 2019). But, half of students assume that mathematics is a very hard and scary subject. It can be seen on questionnaires response from researcher to vocational students, it obtained information that average VS students dislike mathematics subject since it is not directly related to their majoring program and they think that it is a very difficult subject and its learning media is not interesting and unable to direct students to study independently.

Government is consistently supporting the growth and development of education in Indonesia. Vocational school is one of middle school educational institution concerned by the government. Competence program that prioritized by the government divided into four parts i.e. (1) Agriculture; (2) Maritime; (3) Tourism; and (4) Creative industry, according to the President Instruction No 9 in 2016 about the Revitalization of Vocational School. The students need to be prepared optimally based on their majored vocation, it is impacted when they work in industry, and they will be able to compete in International industry. Moreover, these students are also expected to be able to make new job opportunity for others based on their vocation.

According to Regulation of Education and Cultural Ministry No. 34 in 2018, one of competency standard of Vocational School (SMK) graduate is "Having understanding of mathematics in performing their duty according to their majored vocation". For the sub-standard of graduate competency: (1) mathematical thinking related to their field; (2) using factual knowledge, conceptual and procedural mathematics in solving the problem related to their field in logically, critical and creative way; (3) evaluating the accuracy and rightness of problem solving related to their majored filed by using basic mathematics; (4) communicating the result of their problem solving related to their field oral or written systematically. The aim of learning mathematics in VS should be integrated by the goals of vocational program (Sumandya, 2019; Mohan & Kumar, 2018).

According to obtained data, recently the process of teaching mathematics in Vs only focus on National Exam and pursuing the scope of material to be fully discussed. Teaching material of mathematics in Vs only contains the compilation of general mathematics and teaching activity is not only focus on material which need to support the student vocation competency. Mathematics learning which is implemented nowadays is yet able to make mathematics subject become meaningful for Vs students.

Mathematics subject in Vs nowadays is only using mandatory mathematics textbook published by government and supporting book available in bookstore. The example of questions and cases given in this book and available book in market is minimally related to students' vocation. The interview is conducted with teachers; it is done by the teacher since: (1) math teacher is yet able to design vocation based module; (2) Vs mathematics teachers yet have any training for developing vocation based mathematics subject module; (3) less motivation of teachers to develop vocation based mathematics subject module; (4) there are less literatures supervise them to be creative in developing vocation based teaching module.

According to that case, so the mathematics learning in Vs should be based on majored vocation by students. Based on the facts above, it needs change of learning system. In revolution industry 4.0 era, where information technology and communication more focus on daily activity (Sumandya, 2018; Amen *et al.,* 2019; Estevez *et al.,* 2018). To solve this

case, it needs compatible learning media toward recent technology development without vacating the goals of vocational study, so the developed learning media can be right on target to the needs of students.

Vocation based E-module is an electronic version from printed module and can be viewed on computer and smartphone, so it can be more interesting and interactive (Aminatun *et al.,* 2016; Borris & Zecho, 2018; Alava *et al.,* 2018). E-module is a learning tool that accommodate material, limits, method, evaluating technique that arranged accordingly and interesting to achieve the demanded competence based on the level of complexity electronically (Kuusimäki *et al.,* 2019; Rodriguez *et al.,* 2020; Akpomedaye, 2019). It can be concluded that e-module is good to be applied for increasing students' participation during teaching process. As for used software to create e-module is *flipbook maker*. This developed module is expected to be able to support students of Vs to have understanding of Mathematics in performing their duties according to their expertise.

Method

Method used in this research is design research with developing research type (Plom & Nieveen, 2010). It aimed at obtaining valid, practical and effectivevocation based e-module to improve the mathematics learning outcome for student of Vocational School (SMK). The taken step for this research consisted of three stages, i.e.: Preliminary Research, Prototyping and Assessment (Plom & Nieveen, 2010; Fitri *et al.*, 2018; Nurhayati *et al.,* 2017). This research was conducted in XI class of Vocational Schools in Badung Regency. For the Preliminary research was the first stage, the researcher analyzed the needs and literature study in this stage. Afterward, prototyping stage, the researcher designed and developed mathematics e-module based on vocation, named draft 1. Assessment stage was conducted by using three techniques, i.e.: first, it was begun by doing validation from expert team, the revision result from experts (master) named draft 2. Second step was draft 2 then examined on small sample (limited trial) to observe the practicality, its revised result named draft 3. Third step was field trial by using draft 3, where it was conducted to see whether this vocation based mathematics e-module is effective to be used in improving students learning outcome. The result of draft 3 named final product (Effendi, 2019; Palacios *et al.,* 2019; Alcívar *et al.,* 2019).

The collecting and technique of analysis data in this research were including documentation, questionnaires, observation sheet, interview and test. The documentation was conducted to collect the result of comment or suggestion from validator, comment and suggestion from students and teachers, the answer from students and photos during this research. This technique also was conducted during experts' validation trial, limited trial and field trial. Questionnaires was distributed to group during limited trial. Observation sheet and test was given in field trial. Interview was held while preliminary research, prototyping and assessment. Afterward, the result of documentation, suggestion sheet, observation sheet and analysis were analyzed qualitatively. Questionnaires and test were conducted to see the potential effect of prototype which was produced through students learning outcome. Potential impact of this research can be seen through questionnaires percentage and completeness of learning outcomes before and after applied this mathematics e-module on mathematics teaching in Vocational schools. This research used formula to calculate N-gain which was normalized and interpreted by (Sulistyaningsih & Aziz, 2019; Menéndez *et al.,* 2019; Widiartini & Sudirtha, 2019).

Result and Discussion

This research has obtained e-module of mathematics based on vocation with valid quality, practical and effective to be used by students and teachers in mathematics learning in Vocational School (SMK). Development procedure in this research is: Preliminary research, prototyping and assessment (Plom & Nieveen, 2010). On preliminary research stage was conducted analysis of needs and literature study as the baseline of developing vocation based mathematics e-module. Analysis of needs was done by distributing the questionnaires through *google form* to the respondents in every Vocational Schools in Badung regency Bali Province. It obtained 35 respondents of teacher and 120 respondents of students, the recapitulation of questionnaires from result of needs analysis can be seen in table 1 and table 2, as follows.

Table 1. Result of Needs Analysis on 35 Mathematics Teacher Respondents

No	Indicator	Questionnaires Outcome
1.	Curriculum and Teaching Method	87,8% has done learning process based on ICT, 25% as media creator and 75% as users
2.	Knowledge of learning media.	They as users from available application in internet such as *bambumedia*, *zenius*, *ruang guru* and *rumah belajar*. If as the creator, mostly make blog which as limited integration level
3.	Developing e-module mathematics based on vocation	100% are supporting the developing of vocation based e-module in mathematics learning
4.	Teachers' expectation on developing vocationbased mathematics e-module	The highest three of questionnaires result is 58% of learning media can be accessed anywhere and anytime and can be accessed by using smartphone, 45% media are able to report the learning outcome even for assignment or test, 36% learning media can show the mathematics teaching material that integrated with simulation/ animation/ learning video and related to students' vocation program
5.	Category of main discussion which difficult for students	Linear Program

Table 2. Result of Needs Analysis on 120 Student Respondents

No	Indicator	Questionnaires Outcome
1.	Teaching method in class	58% teacher done lecture technique by using power point presentation as assisted media on presenting material, 69% have difficulties to study mathematics and delivered material is irrelevant to their expertise program
2.	Learning supporting facilities	Generally, more than 92% stated that the supporting facilities for e-module learning media is already well-provided in each schools.
3.	Teaching media	98% agree for developing vocation based mathematics e-module

No	Indicator	Questionnaires Outcome
4.	Expectation and advantage of developed media	The highest three of questionnaires result is 70% of teaching media which simplify to study mathematics, 64% learning media which provide complete material with simulation/animation/learning video, 57% learning media can suggest to solve the problem related to students majoring program.

Generally, the result of questionnaires from teachers of students' responses, the needs for developing teaching media which easy to use, accessible anytime anywhere, material content which can be easily understood and applicable in solving problem related to students majoring program and learning material completed with simulation/animation/learning video.

For the finding above, it needed to find the solution that can accommodate the result of field needs. Besides analysis of needs, the researcher also conducted literature study such as curriculum study according to the Ministry of Education and Culture Regulation No 34 in 2018, one of Vocational School Graduate Competence Standard "Having Mathematics Understanding in Performing Duties Based on Majored Program". Sub-standard of Competency: (1) mathematical thinking related to the work field; (2) using factual knowledge, conceptual and procedural mathematics in solving problem related to the majored vocation in logic, critical and creative way; (3) evaluating the accurate and rightness of problem solving related to majored vocation by using basic mathematics; (4) communicating the result of problem solving related to the majored vocation in oral or written systematically. In accordance to the result of previous research by (Sumandya, 2018; Suryasa *et al.,* 2020; Rinartha *et al.*, 2018), that the goal of mathematics learning in vocational school should be directly integrated with the goals of the vocation program.

In prototyping stage was developed e-module mathematics based on vocation according to the studies found in preliminary research stage, the prototyping result named draft 1. In figure 1 and 2 is showed the cover page and main menu of vocation based mathematics e-module.

Figure 1. Display of Cover Page of Vocation based Mathematic E-Module

Figure 2. Display of Main Menu Vocation Based Mathematics E-Module

Some features in main menu are (1) direction feature contains information how to use e-module mathematics based on vocation; (2) introductory feature contains the background information, advantage of e-module, title of main discussion and thank-you note; (3) feature material 1 and 2 contains about main discussion and the assignments for

students; (4) evaluation feature contains examples to measure the learning outcome; and (5) feature about the contact person and identity of e-module.

Next step was Assessment stage. Before, product tried in small group and field trial, validation test was conducted in advance. Validating was held by two experts, i.e. media expert and expert of material or content of e-module. The result of media expert assessment can be seen in table 3 and expert of material/content of e-module can be seen in table 4.

Table 3. Result of Media Expert Assessment

Validator	Aspect of Assessment					Average (%)
	Presenting		Layout		Usage	
	Multimedia	Reader Convenience	Design	Display Consistence	Convenience User	
I	90	78	84	78	90	84
II	80	74	80	76	85	79
Average (%)	85	74,5	82	77	87,5	81,5

Obtaining validation result of media expert can be described by using 5 assessment indicators i.e. presenting multimedia 85% with *excellent*category, reader convenience 74,5% with *good* category, design layout 82% with *excellent* category, layout display consistence 77% with *excellent* category and convenience user 87,5% with *excellent* category. So, generally the overall result from media expert get score 81,5% with *excellent* category. Revision conveyed by media expert team generally between increasing font size on e-module, revising background cover display of e-module, increasing size and video resolution, noise sound from video recording file is edited neatly and font color of direction is suited to the reader convenience. Table 4 below show summary of material expert assessment.

Table 4. Result of Material Experts Assessment

Validator	Aspect of Assessment				Average (%)
	Appropriate content of teaching material				
	Basic Competence	Content Delivering Strategy	Writing language style	Consistence of using language style	
I	89	82	84	81	84
II	92	78	82	76	82
Average (%)	90,5	80	83	78,5	83

Obtaining result of material/content of e-module expert (table 4) can be described by 4 indicators of assessment i.e. basic competence 90,5% with excellent category, content delivering strategy 80% with *excellent* category, writing language style 83% with *excellent* category and consistence of using language style 78,5% with *excellent* category. Generally, the overall result from material experts get 83% with *excellent* catagory. Revision delivered by material expert team generally between *home* display of class catagory should be changed into mathematics description catagory, resolution graphic image animation, font size should be consistent and enter more HOTs examples. The HOTS problem is a question demanding students analyze, evaluate a problem including creating new or other work steps (Mahendra, 2019). After doing the revision based on suggestion from experts team,

this vocation based mathematics e-module that has been developed is ready to be examined.

Afterwards, the produced draft 2 was tested limitedly on small group to see the practicality, named draft 3. The result of questionnaires related to e-module obtained from professional math teacher and students in small group can be seen in table 5.

Table 5. Result of Questionnaires Response related to vocation based mathematics e-module product

Respondent	Average Score (%)	Category
Professional Mathematics Teacher	86,5	Excellent
Student	88,4	Excellent

Form the mathematics teacher response obtained score 86,5% with excellent categpry, this show that e-module of mathematics based on vocation is practical to be used in mathematics learning. Besides, they give several positive comment and suggestion such as: (1) E-module mathematics based on vocation is helpful for student as teaching material beyond the school since it is completed from content, question practice and esplanation; (2) especially in description in form of video is accessible anywhere and everywhere; (3) the problem that used is related to their gastronomy major program, students got more enthusiasm solve the given problem in module; (4) Interface to open a bit need time in leading so it need to be revised, less compatible if opened via smart phone or the small screen size (there are some display distorted on smart phone screen).

Result of students' response on limited trial obtained score 88,4% with *excellent* category, moreover they give some positive comment and suggestion, such as: (1) this media is the best among other application they know, it is good to study at home, practical question and main discussion related directly to the majored program, gastronomy; (2) Adding other main discussion on e-module, since there are only have linear program; (3) E-module needs to be revised so it can be more compatible on small screen size.

Revised result based on suggestion from limited trial, then examined again on bigger group to obtain the affectivity toward the achieved competency of mathematics by giving pre-test, treatment, post-test named *one group Pre-test, Post-test.* The example of student answer during post-test can be seen in figure 3.

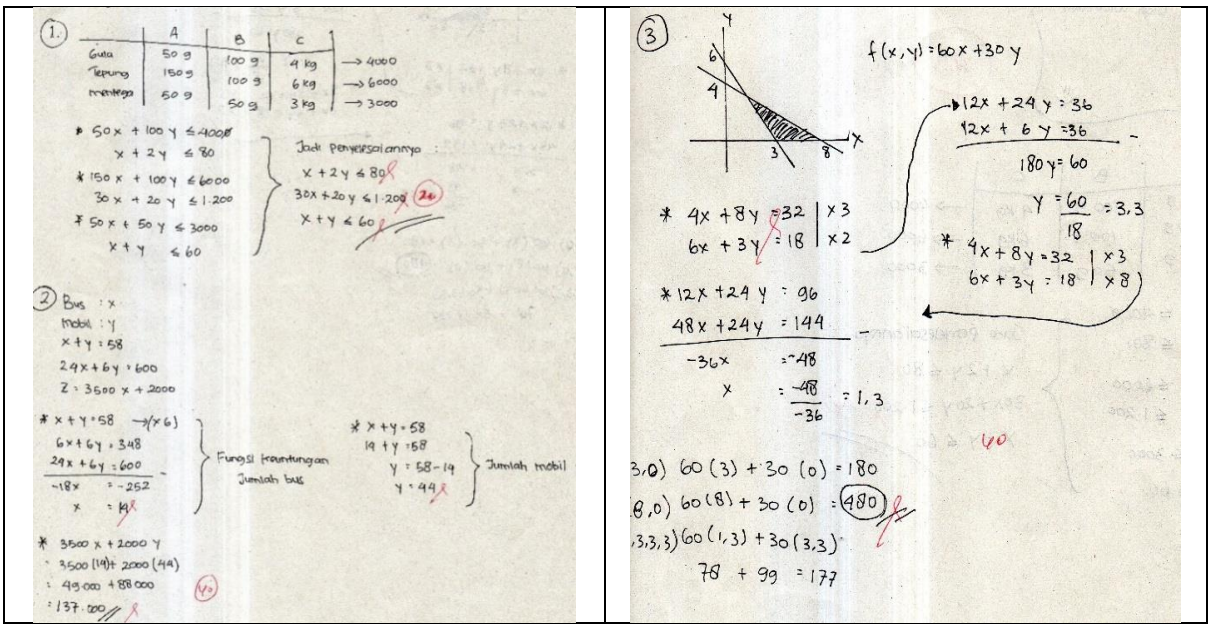

Figure 3. The Example of Students' Answer During Post-Test

Result *N-Gain* on linear program main discussion can be seen on table 6.

Table 6. N-Gain on linear program discussion

No	School	Average Score of *N-Gain*	Note
1	SMK Negeri 1 Kuta Selatan	0,84	High
2	SMK Wira Harapan	0,82	High
3	SMK PGRI 1 Badung	0,78	High
	Average	0,81	High

According to pre-test result and post-test above and also N-Gain calculation has been conducted so, it is obtained N-Gain about 0,81. Therefore, according to Meltzer (2002) N-Gain which highly obtained since g ≥ 0,7. It can be said that developed e-module of vocation based mathematics is effective in improving VS school learning outcome. It is improved by several factors: (1) students are free to study outside school time, since this e-module can be accessed anytime anywhere; (2) students are more interested to read and do the assignment in e-module since it contains simulation such as interactive video; and (3) there is integration between mathematics problem with majored program problem chosen by the students, it affected students are more fascinated to study mathematics.

Development of mathematics e-module based on open-ended on material system of linear equation of two variables has been done by (Andriani, 2019), in the research obtained developed e-module with valid quality, practical and effective for VII Middle School students. The research from other field (Rendra *et al.*, 2018) discovered more advantage of e-module i.e.: (1) Web design E-module convenience students in studying independently based on curriculum; (2) Web design e-module increasing student indenpence in achieving completeness mark through project based learning model stages; (3) E-module motivated the students to learn web design, since the learning used e-module brought by students on new learning environment which is yet experienced by them, so it stimulated their curiosity in learning by using e-module makes them more excited to study.

Conclusion

Product that produced in this research is vocation based mathematics e-module with valid quality, practical and effective. The validation trial from media expert obtained average 81,5% meanwhile validation trial from material/content e-module experts obtained 83%, this shows that the developed product is valid and appropriate to use. Limited trial on small group to assess the practicality obtained average response from professional mathematics teacher is 86,5%, meanwhile average response from students obtained 88,4 with *excellent* category. Average response of both students and teacher shows that vocation based mathematics e-module is practically used in learning mathematics for Vs students. The field trial was conducted to see the affectivity obtained by N-Gain about 0.81. Therefore, according to Meltzer (2002), N-Gain highly obtained since g ≥ 0,7. It can be said that this module is effectively improving VS students learning outcomes. It is able to train students to applied mathematics concept into their vocational, moreover, students can study anywhere anytime without waiting for face-to-face time in class. The availability of integration among mathematics teaching material and study program of students can make VS students fascinated to participate and do the mathematics assignment in module. This research is not only ended here, toward other researcher should develop vocation based mathematics learning for vocational school students.

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Notes on contributors
I Wayan Sumandya- Department of Mathematics Education, IKIP PGRI Bali, Indonesia

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