

Development Of A Vocational Based Mathematics E-Module

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Abstract: This research aims at developing a mathematics e-module based on vocation with valid, practical and effective quality. The model used is the ADDIE model. It is implemented to the XII students of Wira Harapan Vocational School. The validity is assessed by three material experts and three media experts by using evaluation form and assessed with the Gregory cross-tabulation. The practicality is evaluated by distributing questionnaires to students, teachers and observation. The result shows that the developed e-module has passed practicality criteria, from students, teachers or observation. The average score of practicality by students 0.89 and it is categorized into "very good" criteria, 0.86 by teachers and classified as "very good" too and based on observation, the obtained score is 0.90 and also in "very good" classification. The effectiveness of e-module is evaluated by giving the learning outcome to the students and analyzed by Independent Samples Test. The result analysis obtains t-value = -3.87 with Sig. (2-tailed) 0.00 less than 0.50 it means the e-module is effectively implemented in improving students' learning outcome. The primacy of this e-module for the research is using problem or questions of mathematics based on vocation related to the vocational students practice and they could study independently or in group flexibly.

Index Terms: E-module, Vocation, Covid-19

1 INTRODUCTION

The structure of Vocational School Curriculum assigns mathematics subject as the compulsory subject and included into B group. Mathematics is one of important subjects for vocational students, since it is dominant in developing sciences and technology [1]. According to the regulation of Minister of Education and Culture No 34 of 2018 as one of standards of Graduate Competency for Vocation School is "Having understanding of mathematics in conducting responsibility regarding the skill". Meanwhile, the sub-standards of graduate competency are: (1) thinking mathematically related to its field; (2) using factual, conceptual knowledge and procedural mathematics in solving problem related to its area of expertise logically, critically and creatively; (3) evaluating the statutes and rightness of problem solving related to its skill based by using basic mathematics; (4) communicating the results of problem solving related to its expertise in oral and written systematically [2]. Mathematics is subject that able to develop creativity and emphasize on solving the problem [20]. It has many branches such as algebra, geometry, arithmetic and analysis [3]. It is able to direct students to get used to solve the problem and it makes students used to think mathematically, in logic, rational and critical way [4], however some students of vocational school assume that mathematics is unrelated to their vocation, it affects their low interest in math. Moreover, during COVID-19, the learning or studying process is conducted online overall. It is proved by the questionnaires finding and analysis by the vocational students. It shows that they are more interested in learning their vocational subjects or productivity than mathematics. Besides questionnaires and students response, the students' results provide the information of mathematics average score is lower than productivity subject and more students get mathematics score below the minimum standard (KKM) rather than students with above standard. In order to solve this problem, it needs to develop a mathematics e-module related to their vocation or study program. In accordance with the previous research by Sumandya in 2019 entitled Developing Assessment of Vocation-Based Hots on Mathematics Subject for X Class of Vocational School, it found that students were enthusiast in answering the mathematics questions related to their vocation [5]. The research conducted by Sumandya still focused on Assessment, the weakness of this research that the mathematics learning process was un-

clearly related to the vocational study. Edo & Tasik in 2019 also conducted research entitled Design Research on Applied Realistic Mathematics Education (RME) Approach in Teaching Math for Vocational College, it found that learning mathematics based on vocation could improve students' comprehension and they tended to enjoy the learning process and also they responded it enthusiastically [6]. Edo & Tasik also conducted research in higher school or university, and yet focused on vocational school. Fatimah in 2018 also conducted research entitled Pedagogy Mathematics in Vocational School found that particular characteristic from vocational school was to organize students to work regarding their expertise [7]. Learning mathematics should connect math with science and vocational practice based on their expertise and characteristics [21]. This research was limited on secondary research. She only analyzed the findings from previous studies without conducting experiment or empirical assessment. Effendi also found that math as not only an instrument for solving the problem however should be able to build the logical mindset and fostering positive attitude for the vocational students to make them able and easy to adapt [3]. The vocational students should have good attitude and adaptability in order to be critical, creative and able to self-develop, according to the era and industry. Effendi was successfully developed pyramid curriculum i.e. Math, Science, Social Science and Literature and those formed into rectangular as the base of pyramid. Meanwhile, the vocation program as the peak of pyramid. It means that productive subject in vocational school should be supported by normative and adaptive subjects. There was no previous research that develop mathematics e-module based on vocation for vocational students. Based on empirical data and facts, it is concluded that mathematics learning only contain general mathematics, minimum activities during the process, unfocus on the teaching material for supporting students' skill competence. The learning process of Math in vocational school is insufficient by using only the 2013 Curriculum Compulsory Textbook published by government and supporting books in the market. The example of question and cases has minimum relation toward students' vocation. In order to complete this gap, the researcher developed mathematics e-module based on vocation. It also needed for learning process in the future, particularly during COVID-19 pandemic. It is

expected to assist students in learning math maximally and become a vocational graduate who is ready to compete and overcome the industrial era 5.0.

3 METHOD

The developed product is a mathematics e-module based on vocation with valid, practical and effective quality. The validity score was examined from content and construct variable, the practicality was examined from its implementation in learning process and the effectiveness from students' ability in answering the question during exam [22]. The model used in this research is the ADDIE Model (Analyze, Design, Develop, Implement and Evaluate) [8]. The process is as follow:

Table 1. Instructional Design Phase with ADDIE Model

Analysis	The analysis phase including three elements such as necessity analysis, curriculum and students' character analysis.
Design (Design e-module)	Determining characteristic draft of the e-module, learning characteristics and the principles of learning mathematics based on vocation.
Development (Designing e-module)	Producing and examining the validity toward vocation based mathematics e-module.
Implementation (iteracy process, formative evaluation and revision)	Conducting learning process with the e-module for improving product quality.
Evaluation (penilaian sumatif dan produk final)	Evaluating and revising the e-module in order to produce final product with valid, practical and effective quality.

The subject of trial was adjusted with the research stages, the collecting technique used is purposive sampling [9]. It was implemented in Wira Harapan Vocational School. The instrument as a scoring form for e-module to obtain the data validity, the questionnaires of students and teachers response, the observation form for data practicality and the learning outcome for data effectiveness. The validity and practicality data as qualitative data that was processed quantitatively. The collected data of e-module examination, response questionnaires and observation forms analyzed descriptively by using guidance proposed by Guilford (the following Table 2). The vocation based mathematics e-module claimed has fulfilled the validity and practicality aspects if it pass the "good" minimal score classification [12].

Table 2. The Guidance of E-Module Assessment Classification

Score Interval	Classification
$\bar{X} > 0.80$	Very Good
$0.60 < \bar{X} \leq 0.80$	Good
$0.40 < \bar{X} \leq 0.60$	Sufficient
$0.20 < \bar{X} \leq 0.40$	Bad
$\bar{X} \leq 0.20$	Very Bad

The data of students learning outcome was the quantitative data analyzed by using Independent Sample Test examination to obtain the average difference of two unpaired samples. The vocation based mathematics e-module is effective if the Sig value (2-tailed) is less than 0.5, since there is significant difference between students learning outcome with and without this e-module. It was ineffective if the Sig. value (2-tailed) was more than 0.5, since there was insignificant difference between students learning outcome with and

without this e-module [10].

4 RESULTS

This research has successfully developed a Mathematics E-Module based on Vocation by using the ADDIE Model.

Analysis

The analysis stage was including three dimensions such as necessity analysis, curriculum and student analysis. Generally, it found (1) the vocational students were more interested in learning productive or vocational subject than math; (2) The aim of curriculum in Wira Harapan vocational school as including four competence aspects, such as spiritual attitude, social attitude, knowledge and skill aspect; (3) the students also seemed to give up, they were not able to get the right answer from the questions given by their teacher. In order to solve this problem, the researcher developed a statistics e-module based on vocation.

Design

This research product was a mathematics e-module based on vocation for XII class students overviewed from validity aspect, practicality and effectiveness aspect in learning process. Its characteristics were (1) Using mathematics case or questions related to their vocational practices; (2) It assisted students to study in group or independent anytime and anywhere; (3) It was flexible such as the sound can be muted if it was disturbing, competence evaluation and skill check in online or offline; (4) The answer key of formative test by using video, it made the discussion more interesting; (5) The learning description divided into several activities; (6) There were prerequisites that make students to understand the material before learning this e-module; (7) The learning goal was clearly formulated; (8) The learning material was packed into small units to assist the students in learning to the last session; (9) There were examples and illustrations that support the material clearly; (10) Using simple and communication language style, (11) There was competence evaluation instrument for measuring the skill and evaluating the user comprehension toward material; (12) There was feedback on the assessment for user to know their comprehension level toward material; (13) There was material summary; (14) There was information about reference that support the cited material; (15) There was answer key of competence evaluation. The characteristics of learning mathematics based on vocation (1) Using vocation based mathematics cases or questions related to their vocational practice in the beginning; (2) The e-module led students to develop vertical instrument (Chart, Model, Scheme) discussed in group; (3) The E-module led students to use their learning outcome and construct it; (4) There were discussion material that would stimulate the interactivity in online or offline; (5) There is relation of mathematics material and vocational subject. Meanwhile, the principles in learning vocation based mathematics were (1) There were questions that lead students to rediscover in guided manner which was conducted in group; (2) This e-module contained didactic phenomenon; (3) There were questions that trigger students to develop their own model. The example of mathematics questions based on vocation in this e-module is as follow.



Figure 1. The Vocational students pay attention to the production unit result.

The vocational question narration:

There will be a research about the influence of using natural preserva-tives for bread from production result of gastronomy department of vo-cation students. It consists of 15 packs and as research object, a teacher take 4 breads. Then, its population is the whole bread (15 kinds) and 4 kinds as sample.

Develop

Mathematics problem based on vocation was a beginning step to the next stage of learning mathematics. Here is the cover, table of contents and content of e-module.

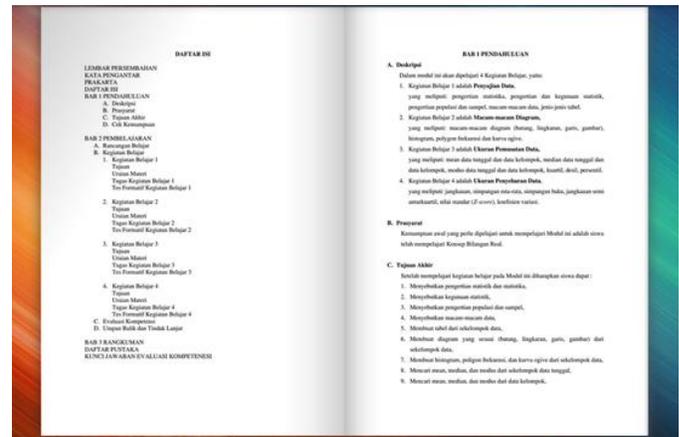


Figure 3. The table of content design for E-Module

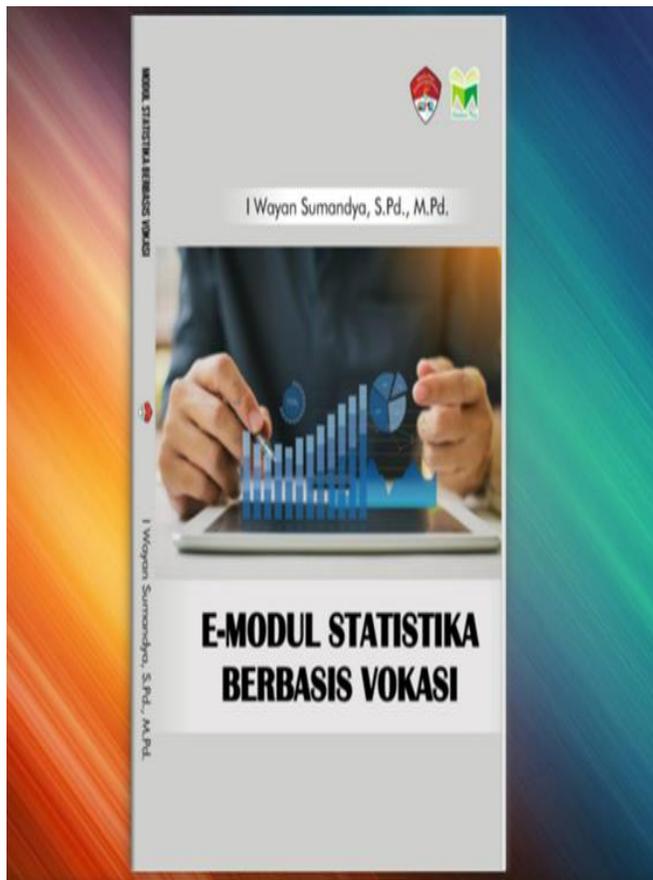


Figure 2. The cover design for e-module

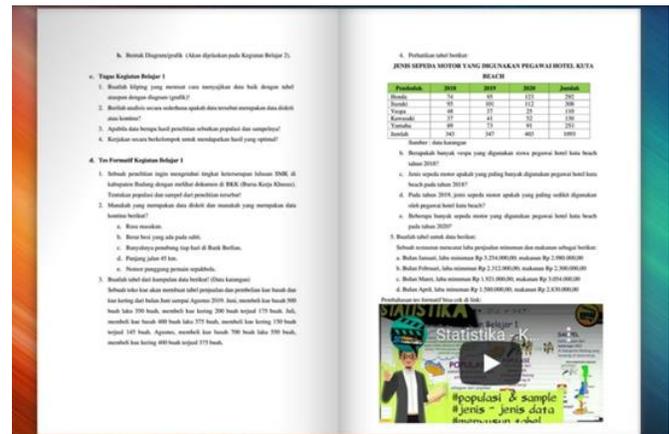


Figure 4. The content design for e-module

The product was validated by three material experts and three media experts. They were appointed based on their experience and relevance toward their expertise. The material experts were validated (1) the content appropriateness that was assessed by its suitability with basic competence, material accuracy, supporting material, material finesse; (2) The presentation appropriateness by the presenting technique, supporting presentation, learning presentation, completeness; (3) The language assessment by straightforward, communicative, dialogic and interactive, suitable with the students development level, sequence and elaboration of paradigm, term usage, symbol and icon; (4) The learning assessment by learning characteristics based on vocation, learning principles based on vocation [11]. The validity result was presented in table below.

Table 3. The Validation Result by Material Experts

Aspect	Average
Content Appropriateness	0.86
Presentation Appropriateness	0.86
Language Assessment	0.85
Learning Process Assessment	0.88
Total average	0.86

The analysis of validation by material experts obtained average score 0.86 then this assessment was within interval >0.8, and according to the Guilford guidance, this e-module was categorized into very good classification [12]. It meant that this vocation based mathematics e-module was valid.

The validated criteria by media experts include: (1) The physical size of e-module, (2) The aspect for cover design were its layout cover material, using attractive font style and readable, the cover illustration; (3) The design was assessed by its layout consistence, harmonious layout, complete, advanced understanding, simple typography of content, readable typography, and it assist students to understand the content by ist typography and content illustration [11]. The average score of validation by media experts was 0.84, it was within interval >0.8 and according to the Guilford guidance, it was categorized into very good classification. Then, this means that this e-module is valid by media experts [12].

Implementation

The vocation based mathematics e-module was stated as a valid product by material and media experts, it was implemented in Wira Harapan Vocational School. The aspect for assessment during its implementation was the learning process by using this product to obtain its practicality value [9]. The implementation result is as follow:

Table 4. The Result of Assessment during Implementation

Average Score	Field Trial
Student Response Questionnaires	0.89
Teacher Response Questionnaires	0.86
Observation	0.90

After it was converted regarding the assessment aspect from Guilford, the average score of questionnaires from students has passed “very good” classification. Furthermore, it also obtained from teachers questionnaires score, and classified into “very good” category. The observation result also have “very good” classification. According to the data analysis above, this e-module was very practical to apply in learning math in vocational school. The students learning outcome after using this e-module is presented on table below.

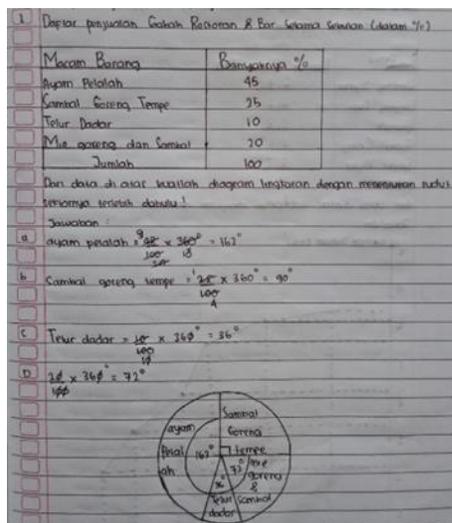


Figure 5. The Example of Student Learning Outcome

The students’ outcome during implementation of this e-module was excellent. They were enthusiast in learning mathematics during the implementation process. The questions used in this e-module were related to their chosen vocation. They were enjoying the process with this developed vocation based mathematics e-module since it was flexible to use in learning math anytime anywhere. The students’ comprehension toward the basic concept of mathematics was good. They were able to construct their own knowledge. The descriptive statistics of students learning outcome in mathematics subject with this e-module and without it has obtained result as follow:

Table 5. The Descriptive Statistics of Students Mathematics Learning Outcome

		Group Statistics			
Mathematics Learning Outcome	Class	N	Mean	Std. Deviation	Std. Error Mean
	Culinary 2	40	71.20	8.68	1.37
	Culinary 4	40	78.13	7.29	1.15

The average score of mathematics that used this e-module was higher than students’ outcome without this mathematics e-module based on vocation. The base of decision making during this research was using Independent Samples Test. Here is the analysis of students learning outcome in mathematics subject by using Independent Samples test.

Table 6. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
M	Equ	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
		3.5	.	-	7	.0	-	1.7	10.	-

at h Le ar ni ng O ut co me	al vari anc es ass um ed	3	0 6 4	3 .8 7	8	0	6.9 3	9	49	3. 3 6
	Equ al vari anc es not ass um ed			- 3 .8 7	7 5. 7 3	.0 0	- 6.9 3	1.7 9	- 1 0. 4 9	- 3. 3 6

The analysis result on table 6 show the t-value = -3.87 with Sig. (2-tailed) 0.00 less than 0.5, it means that this vocation based mathematics e-module is effective to improve students learning outcome.

Evaluation

After implemented in learning process, this vocation based e-module was evaluated and revised based on the findings during test. Some findings and revision during trial test is as follow

Table 7. Findings and Revision

Trial test	Notes for Revision based on Students Response Questionnaires during Trial Test
Finding and Suggestion during trial test	<ol style="list-style-type: none"> 1. Discussion for formative test needs more bandwidth since it was online. 2. Every material needs sufficient examples number. 3. Increasing response from application in order to make learning process faster and effective, make the buttons clearer to reduce the confusion ; 4. Several formulas was unclearly presented; 5. Several numbers with equation was blur; 6. It needed more examples from several restaurant menu; 7. Development of softskill should be more than hardskill; 8. I suggested to use illustration in every material in order to improve students understanding
Revision based on findings and suggestion in trial test	<ol style="list-style-type: none"> 1. It needed answer key and discussion of formative test in offline. 2. More examples have already entered 3. The slow respond buttons have repaired, it was already more effective to use. 4. The unclear formulas have already revised. 5. The questions with equation have repaired and become clearer. 6. The examples related to culinary have already added to the material 7. The softskill development in this model applied in working on assignment in activity 1-4. Students was led to work on that task in group 8. The illustrations have added for several questions example in every activity.

After revision based on findings during implementation was produced final product. The vocation based mathematics e-module with valid, practical and effective quality to use in learning mathematics for vocational students.

5 DISCUSSION

This research has successfully developed a mathematics e-

module based on vocation with valid, practical and effective quality. It has fulfilled content validation aspect since it had been adjusted with applied curriculum and theories as basic academic in developing this e-module. Meanwhile, construction validity was assessed based on its relation between various components that construct this product, it was assessed from its material and media depth aspect [23]. This e-module has been designed based on the content appropriateness aspect such as: Its content relevance with basic curriculum (KD), the material accuracy, supporting material in learning process, and the updated material. The aspect of presenting feasibility such as: its technique, supporting presentation, presenting of learning process, its completeness and assessment aspects such as: straightforward, communicative, dialogic and interactive, suitable for students development, sequence and mindset elaboration, terms use, symbol and icon. The aspect of learning process assessment such as: the characteristics and the principles of statistics learning based on vocation with character education integrated. The aspects of paper size, cover design and content design. The e-module in this research was stated has fulfilled the practicality aspect since there is positive response from students and teachers during its trial session [24]. Based on the observation, it seems that students and teachers have no significant problem during the learning process. The students and teachers were satisfied in learning mathematics subject. It was caused by several issues such as: (1) The Mathematics material has bound to students' vocation; (2) It is flexible to use anytime and anywhere without need to take the textbook; (3) There were discussion material that let students explore their knowledge in group to improve their character on cooperation aspect; (4) There was answer key for formative test such as interactive video, it makes the students able to study independently anytime and anywhere; (5) The competence evaluation with answer key in online or offline, it let them choose the way they want to study and do it repeatedly until they get the right answer. The existence of this mathematics e-module could let student learn flexibly and the material was related to their vocation. It meant, with a designed e-module with proper and logic order and also in accordance with students' academic schedule, they could learn the e-module independently anytime. The students were more ready to take lessons since they already know the material discussed before [13]. Besides, by learning the e-module first, at least they already get the basic concepts of the material that will be discussed in the class and could identify the materials they do not understand and discuss it with the teacher or other classmates. Moreover, they would be able to anticipate the assignment from teacher after class [25]. The students were more ready to do that tasks. Kuusimaki also stated that digital communication is needed in mediating the information, was impossible to do interaction during physical distancing [11]. The digital communication could be seen as a skill needed in the 21st century, including communication technique and competence [14]. The math learning outcome of students was increasing after applying the developed e-module in this research. It was because of : (1) During learning process, students actively involved in doing the cases from e-module; (2) They have no limitation on space and time in studying; (3) The discussion was in online and offline, it made them get more interested to learn since it was not limited on space and time; (4) The vocational cases for learning material were already provided in the e-module; and (5) The students thought that the statistics material they learn

were related to their vocation. The students could adjust their own learning speed. It means, they could set their own speed in learning [19]. As how we know about personal speed in learning are very various, there is student who is fast learner, and also there medium learner student and also a slow learner [15]. Through this e-module, this variety of learner could be accommodated and solved. This finding support the previous studies by experts. A research by Sumandya entitled Developing Assesment Of Vocation-Based Hots On Mathematics Subject For X Class Of Vocational School found that students were enthusiast in answering math questions related to their vocation. The developed assessment was very high quality from validity, practicality and effectiveness aspect [5]. A research by Edo & Tasik also found learning mathematics based on vocation could improve students' comprehension and they could enjoy the process and respond it enthusiastically [16]. Math is not only an instrument for problem solving yet it has function to build empirical mindset and stimulate positive attitude for vocational students for adapting in industry [17]. The vocational students should be able to adapt in order to be critics, creative and able for self-development regarding the era development and industry. Effendi also has successfully developed pyramid curriculum i.e. Math, Science, Social Science and Literature create rectangular as the base of pyramid, meanwhile Vocational Program as the peak. It means that productive subjects in vocational school should be supported by normative and adaptive subject [18]. The researches above stated that mathematics learning based on vocation was more interesting for vocational students. The existence of this e-module is very helpful in improving learning effectiveness.

7 CONCLUSION

This research has successfully developed a vocation based mathematics e-module with valid, practical and effective quality used in learning process. The characteristics of this e-module are (1) Using mathematics questions based on vocation related with vocational students' practices; (2) This e-module assists students in studying independently or in a group flexibly; (3) Flexible such as the sound can be muted if it distract; competence evaluation and skill checking in online or offline; (4) The answer key of formative test in form of video, it makes the learning process more interesting; (5) The learning description divided into several activities; (6) There are prerequisites that require students to learn the material in advance, before learning vocation based mathematics e-module; (7) The goal of learning has clearly formulated; (8) The learning material has designed into small units or specific to simplify learning process totally; (9) There are examples and illustrations that support the explanation of learning material; (10) Using simple and communicative language; (11) There is competence evaluation instrument used to measure or evaluate the level of user understanding; (12) There is feedback for assessment, therefor the user know about their level of material comprehension; (13) There is summary of learning material; (14) There is information about references that support the learning material; (15) There is answer key for competence evaluation. The characteristics of vocation based mathematics learning are (1) The used for mathematics questions based on vocation related to students vocational practice in the beginning session; (2) The E-module leads students to develop vertical instrument (chart, model, scheme) discussed in group; (3) The e-module lead students to use

their outcome and construct it; (4) There are discussion materials that could trigger the interactiveness in online or offline; (5) There is relation between mathematics material and vocational material. On the other hand, the learning principles of mathematics learning based on vocation are (1) There are questions lead students to rediscover with guidance that work in group; (2) The e-module has didactical phenomenon; (3) There is questions that stimulate student to develop their own model. Based on this research findings, the developed e-module is able to improve students' math learning outcome during COVID-19.

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