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The Development of Project Based Learning Module for Vocational High Schools to Improve Critical Thinking Skills

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ABSTRACT

Critical thinking is one of the skills needed by vocational high school students in the world of work and has a positive impact on students' fieldwork practices. Therefore the aim of this research is to produce a mathematics module focused on critical thinking skills using a project-based learning model. Thiagarajan's 4D development model, namely define, design, develop, and dissemination, is used in this research and development model. Validation tests, questionnaires, observations, interviews, and critical thinking tests were used to collect data. Data analysis was carried out quantitatively and qualitatively. Quantitative analysis uses descriptive statistical tests and T-tests while qualitative analysis comes from suggestions and input from media experts, materials, practitioners, teachers, and students. The results showed that: (1) the mathematics module for grade 11th vocational high school met valid criteria based on the assessment of material experts, media experts, practitioners, teachers, and students; and (2) with a sig score of 0.000 from the T-test, students who took the module these have better critical thinking skills than those who don't. So that this module can be classified as effective for use in learning. This indicates that this module meets the requirements for use in learning.

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A. INTRODUCTION

Vocational High School is a type of formal education intended for students who want to enter the labour market immediately after finishing school (Republic Indonesia Law Number 20 Year 2003). To achieve this goal, vocational students receive education that is relevant to the needs of the labour market (Government Regulation No. 29 of 1990 on Secondary Education). Vocational students receive not only theoretical but also practical training in their chosen career field. The goal of theoretical learning is to prepare students to provide a knowledge base relevant to their chosen workplace (Eryandi & Nuryanto, 2020). Meanwhile, practical learning includes productive programs based on theoretical learning's values (Lestari et al., 2020). In the world of work, many skills are needed, one of which is the ability to think critically (Changwong et al., 2018). Employees who have entered the world of work agree that this ability must be possessed by graduates (Cruz et al., 2020). High critical thinking skills are proven to prepare someone to interpret, analyse, evaluate, draw conclusions and explain data (Selviana et al., 2016).

Despite the fact that the ability to think critically is one of the skills required of vocational students, studies from several researchers show that the critical thinking ability of vocational students in some city in Indonesia need to be improved. According to Putriani and Aini, the critical thinking of vocational students in of vocational school in Karawang is in moderate category (Putriani & Aini, 2022). Meanwhile, study from Baidowi et al. (2021) reported that vocational students in Mataram who were expected to be ready to work after graduation had low critical thinking skills. In line with this study, Lestari et al. (2020) revealed that students' critical thinking skills remain low in one Semarang school. Another study from Wibowo, Ari et al. (2018) revealed that vocational students in Boyolali have poor critical thinking skills.

Effective vocational education teaching and training of students has become considerably more necessary in order to react to the large number of unskilled employees (Agboeze et al., 2013). Developing critical thinking skills is one way to improve the skills of prospective workers from vocational schools. Various learning models can be used to accommodate critical thinking skills. Project-based learning is one of the lessons that can support students improve their critical thinking skills (Sasson et al., 2018). This learning is also considered to be capable of bridging the gap between the needs of the business world and the learning needs of students Cho & Brown, (2013) so it is expected to be appropriate for vocational students who are ready to enter the workforce immediately. Students in this learning are asked to complete a task under the supervision of the teacher and explain their findings without being given a theoretical explanation first, as in traditional classes (Serin, 2019). This learning is similar to the situation in the workplace because, instead of knowing the theory first, the problem appears without any prior delivery of material. Thus, project-based learning is thought to be ideal for use in vocational education that emphasizes skills.

Teachers and teaching materials are two factors that influence the success of project-based learning (Megayanti et al., 2020). The teacher's ability to understand each stage of learning influences learning activities (Du & Chaaban, 2020). Interviews with several vocational mathematics teachers in Mataram city, Indonesia, revealed that teachers still don't have a clear figure of how the implementation of applicable learning is carried out according to the character of vocational students at school. They stated that it was easier to carry out instruction when the teaching materials offer specific instructions for conducting mathematics project-based learning.

International and national research have studied the development of mathematics modules for vocational high schools. In Spain, there are vocational training modules used by vocational students majoring in engineering to improve their mathematical competencies (Isidro & Calle, 2014). Meanwhile, in Indonesia, there is a development of e-module using project-based learning with STEM to increase mathematical literacy of vocational student (Hadiyanti et al., 2021). Yaniawati et al. (2021) use vocational students as subjects to test the effectiveness of their module to improve students' self-regulated learning. Unfortunately, not many studies have developed mathematical modules for vocational schools that focused on improving critical thinking skills.

Several researchers have also researched the development of teaching materials for vocational high schools to improve student's critical thinking skills. Insani et al. (2021) developed a STEM-based mathematics learning tool to improve the critical thinking skills of vocational high school students in the subject matter of arithmetic sequences and series. Pertiwi et al. (2021) have also developed mathematics learning tools (syllabus, lesson plans, and student worksheets) with problem-based learning models on the matrix material to improve students' critical thinking skills.

Several previous studies have developed learning to improve critical thinking skills specifically for the field of mathematics. However, this research will focus on developing modules using a project-based learning model for vocational students by implementing the independent curriculum or Merdeka Curriculum (one of the applicable curricula in Indonesia) which has not been done by many other researchers. Prior study has revealed a need of mathematics education teaching material for vocational students that are aimed at improving critical thinking skills. After considering the demands of educators and previous research, this study attempts to bridge the gap by developing a vocational mathematics teaching module to improve critical thinking abilities. As a result, the goal of this research is to create a project-based learning module for vocational high school students in order to enhance their critical thinking skills

B. METHODS

This study uses the R&D (Research and Development) technique and is a development study. The final outcome is a project-based learning model-based Module for Vocational High Schools. The process used to create the final product is based on the 4-D Thiagarajan development model, which has four stages: preliminary (define), planning (design), development (develop), and dissemination (disseminate) (Thiagarajan, 1976). The following is the Thiagarajan 4-D model flowchart, as shown in Figure 1.

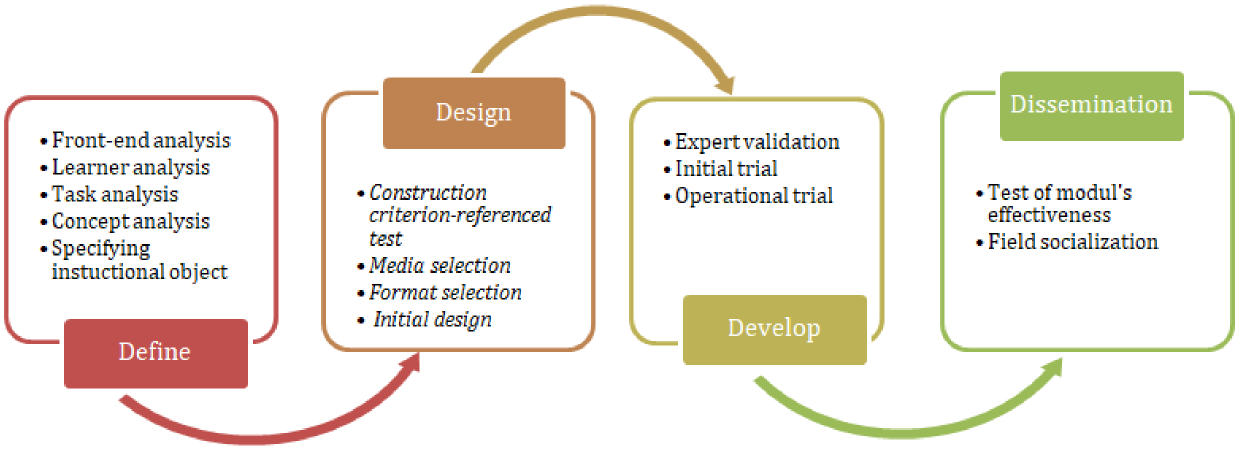


Figure 1. 4-D Thiagarajan Model

1. Define Stage

This stage includes literature studies and field surveys to identify problems (Ekantini & Wilujeng, 2018). Front-end analysis in this study was performed to explain why module development was required. The analysis was carried out by (a) reviewing the teaching materials published by the Ministry of Education and Culture for the Independent Curriculum at the vocational high school level for grade 11th; (b) conducting a study of the independent curriculum at the vocational high school; (c) conducting interviews with vocational high school mathematics teachers about the need to use module-based learning projects for grade 11^{th}; and (d) school observations regarding the modules used during learning.

The stage of learner analysis is used to identify the characteristics of students that will be used in the field trial. This identification process is carried out by analyzing student data to determine student profiles. The class teacher was then interviewed to figure out the specifics of the student's learning styles in the class. Furthermore, a task analysis is carried out to identify the main skills that students will learn. At this stage, core competencies, as well as specific learning objectives, are chosen. According to prior research conducted by researchers at this vocational school, students' critical thinking skills need to be strengthened (Baidowi et al., 2021). Therefore, the specific goal of the teaching materials created is to improve students' critical thinking skills.

Moreover, concept analysis is used to accomplish the key goals of the created modules, such as the subject matter to be studied by students. In order to learn more about the requirements for the course material to be taught in class, researchers interviewed teachers to learn about the specifications of the subject to be given in class. The researcher then chooses material that is relevant to the project-based learning module.

The last analysis is specifying instructional object. In this activity, the researcher wrote out the main goal in a more explicit and quantitative form so that they may be included in the learning activities. In this instance, developing critical thinking abilities is the major goal of the module. By adjusting these goals to the subject matter to be taught, these objectives are thus made more measurably.

2. Design stage

The design stage includes the initial product design activities. Compiling a construction criterion-referenced test, media selection, format selection, and initial design are all steps taken at this stage (Rizki & Linuhung, 2016). This stage collects data through observation, documentation, interviews, and a review of the literature.

In compiling a construction criterion-referenced test, the standard reference test is designed to meet the learning objectives. The standard reference test is translated into a knowledge test in the teaching materials to assess students' critical thinking skills. The test use indicators of critical thinking skills, namely checking the truth of the statement, answering with reason and identifying relevant and irrelevant data (Kertiyani et al., 2022).

In the media selection, the researchers select whether to use printed or electronic modules at the media selection stage. To determine this, the researcher interviewed the teacher about suitable media based on the student's personality. In format selection, the researcher establishes the appropriate formal modules. This format is adaptable to the regular modules used in vocational high school. Furthermore, in the initial design activity, the researcher created a module based on an analysis of the prior activity. If the initial design has been finished, then further research enters the development stage.

3. Develop Stage

Expert validation activities, product revisions, initial trials, and operational trials are all part of the develop stage. The expert validation data will be analyzed quantitatively descriptively by calculating the average score of three validators. In addition, the average acquisition of each aspect is converted using the conditions (Ratumanan & Laurens, 2016), as shown in Table 1.

Table 1. Module Quality Category

Score Interval	Category	Information
$1 \leq P \leq 1.75$	Very invalid	Not yet usable and still in need of consultation
$1{,}75 \leq P \leq 2.75$	Not valid	Can be used with multiple revisions
$2.75 \leq P \leq 3.25$	Valid	Can be used with enough revisions
$3.25 \leq P \leq 4.0$	Very valid	Usable with minor revision

Note: $P =$ average acquisition of each questionnaire from three validator

The initial trial was conducted on 6 students, namely 2 students with high abilities, 2 students with moderate abilities, and 2 students with low abilities in one of the vocational schools in Mataram City. Six students were chosen to represent various levels of student ability related to the modules that have been developed. After the module was tested, students were asked to fill out a response questionnaire. The results of this response questionnaire become input for revising the teaching module.

The operational trials were carried out in one of the classes in one of the Vocational Schools in the city of Mataram. After completing the trial, students were asked to fill out a response questionnaire. The results of this response questionnaire are input for revising the module. The questionnaire used in the initial and operational trials used a Likert scale. After being filled in by students who took part in the trial, scoring was carried out. The classification of student questionnaire results is carried out according to Table 2 (Widoyoko, 2009). For Table 2, $\bar{X}_i$ equals to $^1/_2$ (ideal maximum score + ideal minimum score), sb_i equals to $^1/_6$ (ideal maximum score - ideal minimum score) and X equals to empirical score, as shown in Table 2.

Table 2. The Formula to Determine Interval Classification

Formula	Classification
$X > \bar{X}_i + 1{,}8 \times sb_i \iff X > 3{,}4$	Very good
$\bar{X}_i + 0{,}6 \times sb_i < X \leq \bar{X}_i + 1{,}8 \times sb_i \iff 2{,}8 < X \leq 3{,}4$	Well
$\bar{X}_i - 0{,}6 \times sb_i < X \leq \bar{X}_i + 0{,}6 \times sb_i \iff 2{,}2 < X \leq 2{,}8$	Enough
$\bar{X}_i - 1{,}8 \times sb_i < X \leq \bar{X}_i - 0{,}6 \times sb_i \iff 1{,}6 < X \leq 2{,}2$	Not enough
$X \leq \bar{X}_i - 1{,}8 \times sb_i \iff X \leq 1{,}6$	Very less

4. Disseminate Stage

The disseminate stage consists of field socialization activities as well as testing the module's effectiveness based on student scores and final product revisions. The effectiveness test was conducted with two classes from one of Mataram City's Vocational High Schools. One class serves as a control class with no module learning, while the other serves as an experimental class with module learning. The T-test was then used to compare student learning outcomes in both classes. The module was said to be effective if the experimental class performed significantly better than the control class. If not, a revision will be made to address issues that can improve the module's performance.

C. RESULT AND DISCUSSION

1. Define Stage

This stage aims to identify problems and define module development requirements. There are five parts of this stage, namely front-end analysis, learner analysis, task analysis, concept analysis, and specifying instructional objectives (Sumbawati et al., 2018). A front-end analysis was performed to explain why module development was required. Based on the findings of the interviews, students in the class were encouraged to learn mathematics by emphasizing the component of critical thinking skills. However, there aren't many modules available to accomplish this purpose, particularly those aligned with the recently implemented Merdeka Curriculum. As a result, the teacher wants to be able to develop a module to help students improve their critical thinking skills.

The learner analysis stage is used to identify student characteristics that will be used in the field trial. The trial will take place in Geomatics grade 11^{th}. Geomatics consists of 25 male and 8 female students. According to the interview with the teacher, students in that class preferred learning through practice over learning solely through books and written questions.

Furthermore, in the task analysis stage, core competencies, as well as specific learning objectives are selected. According to the front-end analysis, the specific goal of the teaching materials created is to improve students' critical thinking skills. The next stage is concept analysis which is used to accomplish the key goals of the created modules, such as the subject matter to be studied by students. Grade 11^{th} in vocational school learns Vector, Trigonometry, and Circles material. From these topics, we chose trigonometry by considering the suitability of the topic with the project-based learning model.

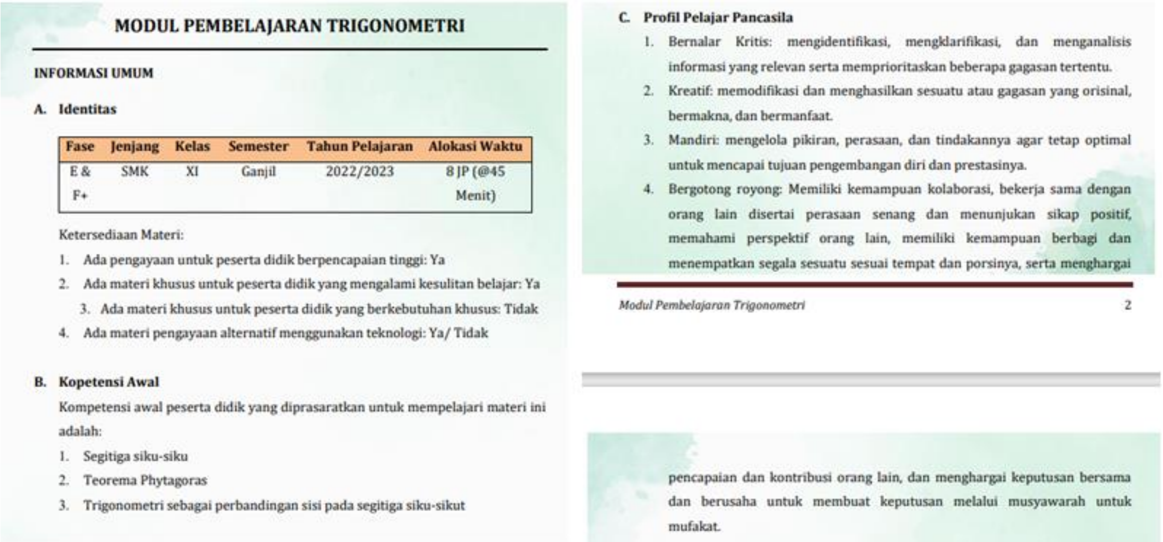
The last analysis is specifying instructional object. In this activity, we adjusted the critical thinking goals to the Trigonometry subject. From that activity, one of the module's specific objectives is to determine the correctness of trigonometric comparisons of an angle from objects in the surrounding environment; students can solve problems related to trigonometric ratios in right triangles using logical reasons, and students can determine the relevance of data when solving contextual problems involving sine and cosine rules.

2. Design Stage

The design stage includes the early product design activities. Compiling a standard reference test, media selection, format selection, and initial design are all activities taken at this stage. For the standard reference test, we use essay test. The essay test contains 3 questions in Trigonometry subject. Each question represents an indicator of critical thinking ability: assessing the truth of a statement about trigonometric comparisons of an angle, students can solve problems related to trigonometric ratios in right triangles using logical reasons, and identifying relevant and irrelevant data while answering contextual problems using sine and cosine laws.

Furthermore, print media will be used in the media selection. This is done because, according to interviews with teachers and students who will be the subjects of field trials, they are more comfortable using print media for teaching materials than other media such as electronic media. Meanwhile, the format of the created teaching materials is in the form of modules that will be used collaboratively by teachers and students. This module uses

Merdeka Curriculum format which uses in vocational high schools. Following that, an initial design of the module that will be developed is created. The initial design of the module is presented in Figure 2, 3, and Figure 4. Figure 2 shows that the module use Merdeka curriculum format, which contains the identity of the module, the availability of the module material, the prior knowledge that student must have, and Pancasila student profile, as shown in Figure 2, Figure 3 and Figure 4.



MODUL PEMBELAJARAN TRIGONOMETRI

INFORMASI UMUM

A. Identitas

Fase	Jenjang	Kelas	Semester	Tahun Pelajaran	Alokasi Waktu
E & F+	SMK	XI	Ganjil	2022/2023	8 JP (@45 Menit)

Ketersediaan Materi:

1. Ada pengayaan untuk peserta didik berpencapaian tinggi: Ya
2. Ada materi khusus untuk peserta didik yang mengalami kesulitan belajar: Ya
3. Ada materi khusus untuk peserta didik yang berkebutuhan khusus: Tidak
4. Ada materi pengayaan alternatif menggunakan teknologi: Ya/ Tidak

B. Kopetensi Awal

Kompetensi awal peserta didik yang diprasaratkan untuk mempelajari materi ini adalah:

1. Segitiga siku-siku
2. Teorema Phytagoras
3. Trigonometri sebagai perbandingan sisi pada segitiga siku-sikut

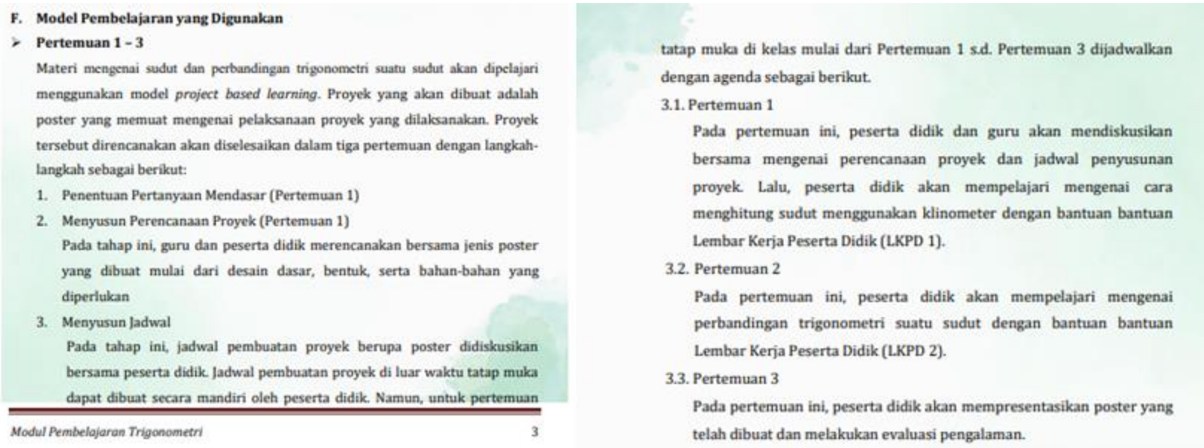
C. Profil Pelajar Pancasila

1. Bernalar Kritis: mengidentifikasi, mengklarifikasi, dan menganalisis informasi yang relevan serta memprioritaskan beberapa gagasan tertentu.
2. Kreatif: memodifikasi dan menghasilkan sesuatu atau gagasan yang orisinal, bermakna, dan bermanfaat.
3. Mandiri: mengelola pikiran, perasaan, dan tindakannya agar tetap optimal untuk mencapai tujuan pengembangan diri dan prestasinya.
4. Bergotong royong: Memiliki kemampuan kolaborasi, bekerja sama dengan orang lain disertai perasaan senang dan menunjukan sikap positif, memahami perspektif orang lain, memiliki kemampuan berbagi dan menempatkan segala sesuatu sesuai tempat dan porsinya, serta menghargai

Modul Pembelajaran Trigonometri 2

pencapaian dan kontribusi orang lain, dan menghargai keputusan bersama dan berusaha untuk membuat keputusan melalui musyawarah untuk mufakat.

Figure 2. Modules in the Format for Merdeka Curriculum



F. Model Pembelajaran yang Digunakan

➢ Pertemuan 1 – 3

Materi mengenai sudut dan perbandingan trigonometri suatu sudut akan dipelajari menggunakan model *project based learning*. Proyek yang akan dibuat adalah poster yang memuat mengenai pelaksanaan proyek yang dilaksanakan. Proyek tersebut direncanakan akan diselesaikan dalam tiga pertemuan dengan langkah-langkah sebagai berikut:

1. Penentuan Pertanyaan Mendasar (Pertemuan 1)
2. Menyusun Perencanaan Proyek (Pertemuan 1)
   Pada tahap ini, guru dan peserta didik merencanakan bersama jenis poster yang dibuat mulai dari desain dasar, bentuk, serta bahan-bahan yang diperlukan
3. Menyusun Jadwal
   Pada tahap ini, jadwal pembuatan proyek berupa poster didiskusikan bersama peserta didik. Jadwal pembuatan proyek di luar waktu tatap muka dapat dibuat secara mandiri oleh peserta didik. Namun, untuk pertemuan

Modul Pembelajaran Trigonometri 3

tatap muka di kelas mulai dari Pertemuan 1 s.d. Pertemuan 3 dijadwalkan dengan agenda sebagai berikut.

3.1. Pertemuan 1

Pada pertemuan ini, peserta didik dan guru akan mendiskusikan bersama mengenai perencanaan proyek dan jadwal penyusunan proyek. Lalu, peserta didik akan mempelajari mengenai cara menghitung sudut menggunakan klinometer dengan bantuan bantuan Lembar Kerja Peserta Didik (LKPD 1).

3.2. Pertemuan 2

Pada pertemuan ini, peserta didik akan mempelajari mengenai perbandingan trigonometri suatu sudut dengan bantuan bantuan Lembar Kerja Peserta Didik (LKPD 2).

3.3. Pertemuan 3

Pada pertemuan ini, peserta didik akan mempresentasikan poster yang telah dibuat dan melakukan evaluasi pengalaman.

Figure 3. The Learning Model used in the Module

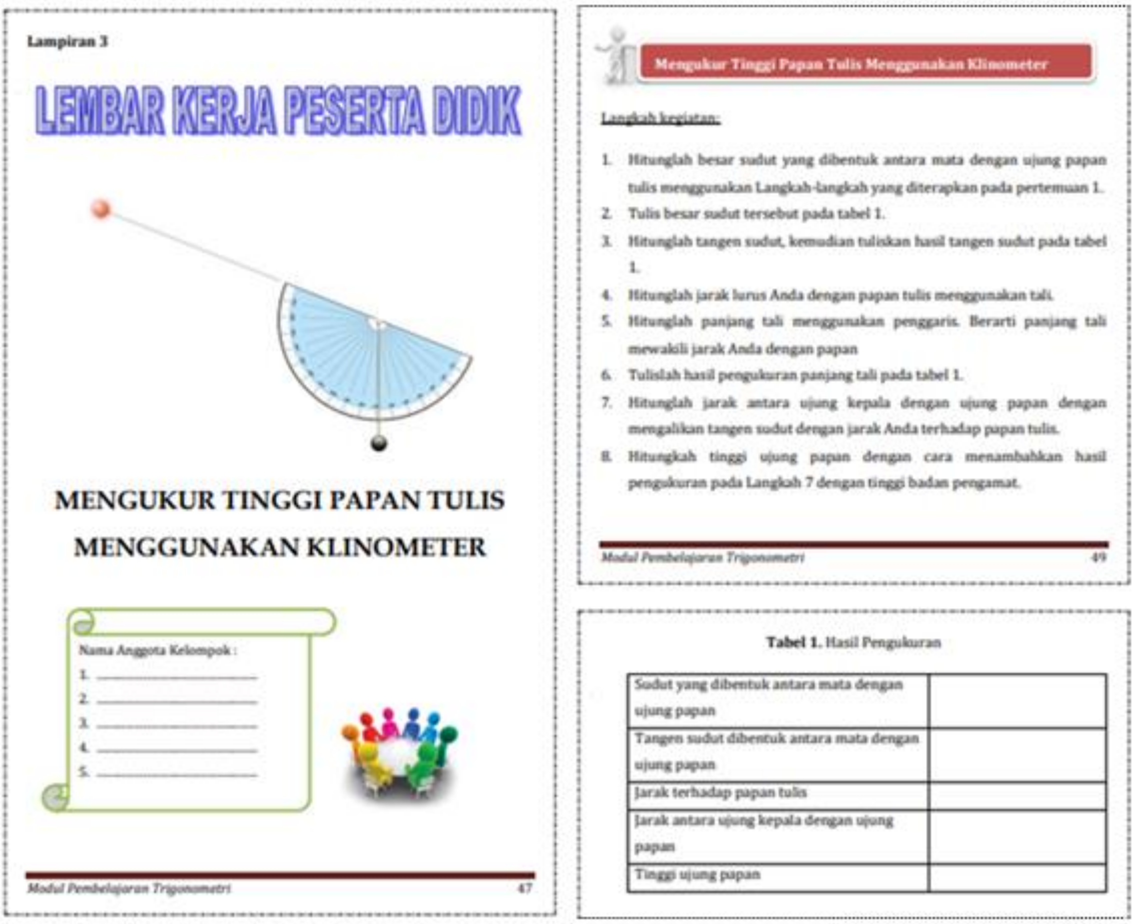


Figure 4. The Project Presented in Module

Figure 3 represents the learning model used in this module, project-based learning, as well as the activity steps in each meeting. Meanwhile, Figure 4 shows an example of a project that students must complete. This project consists of three meetings. Students and teachers discuss project planning and preparation schedules at the first meeting. The learners will then construct a clinometer and learn how to use it to compute angles. Students will study the trigonometric ratio of an angle at the second meeting. Students will also work on a project measuring the height of a blackboard using clinometer ratios and trigonometry during this meeting. Furthermore, at the third meeting, students made posters related to the first and second projects that had been carried out. From the projects that have been carried out, students are asked to make conclusions and each project that has been carried out is then presented in front of the class.

3. Develop Stage

A trigonometric material expert, a media expert (module), and a practitioner perform expert validation. The trigonometric material expert's validation aims to evaluate the material's suitability with the learning objectives and the accuracy of the material presented, whereas the module media expert's validation aims to evaluate the completeness of the components in the module and the appearance of the module. Meanwhile, a mathematics teacher from vocational high school will conduct the operational trial, performed as practitioner experts. The purpose of this validation is to assess the usefulness of the module in learning activities. Table 3 show the result of the validation from three validator, as shown in Table 3.

Table 3. The Validation Result from Three Validator

Material Expert		Media Expert		Practitioner	
Aspect	**Average Score**	**Aspect**	**Average score**	**Aspect**	**Average score**
Content eligibility	4	The size of module	4	Content eligibility	4
Presentation eligibility	4	The design of module cover	3,5	Presentation eligibility	4
Language eligibility	4	The design of module content	3,15	Language eligibility	4
Contextuality of the content	3,85				
The average score of every expert	3,96	3,55		4	
The average score of three validators		3,83			

According to Table 3, the average score of the three validators is 3,83. According to Table 1, this score is categorized as very valid. It means the module is usable with minor revisions. Furthermore, the suggestions from the three validators are shown in Table 4.

Table 4. The Suggestions from Three Validator

Material Expert	Media Expert	Practitioner
• Added hypothetical learning trajectory in module • Corrected a typo on a few pages.	• Each Figure needed to be numbered • The Figures had to be identical in size to one another	The module is ready to use in classroom

The module was revised in response to the validator's suggestions. One of the revised is to add number in each figure. Figure 5 presented one of the development of module in response to that suggestion. The revised module was then used in the initial trial, as shown in Figure 5 and Figure 6.

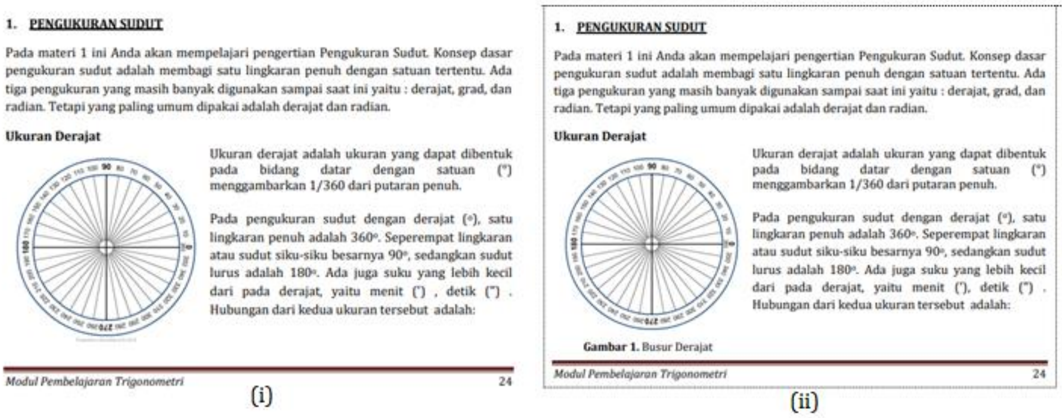


Figure 5. The development of module (i) before and (ii) after revision

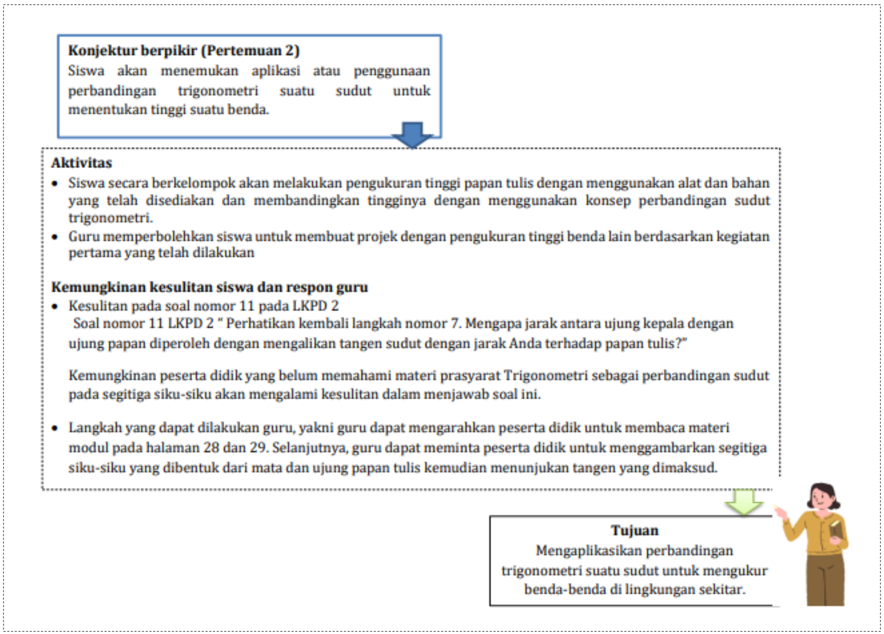


Figure 6. Hypothetical Learning Trajectory that has been Included in Module

The initial trial was conducted with 6 students, namely 2 students with high abilities, 2 students with moderate abilities, and 2 students with low abilities in Geomatics grade 11th Vocational High School in Mataram city. The trial was conducted to determine the readability of the module from the student's perspective. Those students were asked to read the module and did some activity from the module, then filled out the questionnaire. The average score of student's responses is 2,88. It indicates that the classification of the module is good. The module is then used for operational trials.

Operational trials were conducted in Geomatics grade 11^{th} at Mataram vocational high school. The trials were conducted for three meetings with the project-based learning model. After three meetings, the teacher and students completed a response questionnaire. The average student response score is 2,95. According to Table 2, it means that the module is classified as good. Meanwhile, the average teacher score is 3,85. Table 2 indicates that the teacher classified the module very well as well. Because both student and teacher responses indicate that the module is good and very well, it is ready to move on to the dissemination stage.

4. Dissemination Stage

The dissemination stage includes activities such as testing the effectiveness of textbooks based on student scores, final product revision, and field outreach. Experiments were conducted at one of the vocational high schools in Mataram city to determine the effectiveness. Grade 11^{th} Geomatics is an experimental group that learns to use modules, whereas Grade 11^{th} of Business and Motorcycle Engineering is a non-experimental group that learns by not using modules. After the two groups were studied according to the experimental criteria, their critical thinking skills were tested using a module knowledge test. The T-test was then used to analyze the results. The details of the results of the effectiveness test in both groups are as follows. First, normality and homogeneity tests were carried out for critical thinking ability data in both classes. The results are presented in Table 5, Table 6 and Table 7.

Table 5. Geomatics Class Normality Test Results (Experimental Group)

Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
.121	53	.049	.973	53	.272

Table 6. Normality Test Results For Motorcycle Business Engineering Class (Non-Experimental Group)

Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
.177	20	.099	.915	20	.079

Table 7. Homogenious test results

Levene Statistic	df1	df2	Sig.
2.839	1	51	.098

Based on Table 5, sig. obtained is 0.272 > significance = 0.05. This means that the critical thinking ability data for the experimental group comes from a normally distributed population. Likewise in Table 6, the sig obtained is 0.079 > significance = 0.05. This means that the data on critical thinking skills in the non-experimental group comes from a population that is normally distributed. Meanwhile, Table 7 shows the homogeneity test obtained sig = 0.098. This value is greater than the significance = 0.05. This means that the data of the two classes is homogeneous. Because the two data are normally distributed and homogeneous, the independent T test can be performed.

The T-test was carried out with the conditions that H0 = the experimental group's critical thinking ability was the same as the non-experimental group and H1 = the experimental group's critical thinking ability was better than the non-experimental group. The significance used is alpha = 0.025. The results of the independent T test are shown in Table 8.

Table 8. The result of Independent T-test

	t-test for Equality of Means			
	t	**df**	**Sig. (2-tailed)**	**Mean Difference**
Equal variances assumed	3.972	51	.000	20.50758
Equal variances not assumed	3.786	34.378	.001	20.50758

In Table 8, obtained sig (2-tailed) is 0.000. Based on the hypothesis, the test carried out is a one-tailed test, so the sig used is 0.000/2 = 0.0005. This sig. is smaller than the significance = 0.025. This means that H0 is rejected so that it can be interpreted that the critical thinking ability of the experimental class is better than the non-experimental class. Therefore, it can be concluded that the module used is effective to improve students' critical thinking skills.

According to Megayanti et al. (2020), one of the factors influencing the success of student learning is the teaching material, such as module. This study's findings on the effectiveness of modules support that claim. Furthermore, modules are an innovative teaching method that can help students succeed and get better outcomes (Logan et al., 2021; Taufikurrahman et al., 2021). Modules based on a certain learning model can improve student outcomes such as critical thinking (Fidaus et al., 2015; Hikayat et al., 2020; Retnowati et al., 2020).

Following the effectiveness of module, the final product revision and packaging are completed by printing module that have been tested for effectiveness. The module was then disseminated on a limited basis in service activities with the mathematics teacher community at vocational school throughout Mataram City, Indonesia, so that the modules could be used by mathematics teachers from other vocational school in that city.

D. CONCLUSION AND SUGGESTIONS

The result showed that the mathematics module for vocational school grade 11^{th} in this Trigonometry material met the criteria based on the evaluation of material experts, media experts, practitioners, teachers, and students, and its effectiveness was tested, allowing it to be concluded that this module meets the requirements for use in learning. According to that result, we suggest mathematics teacher in vocational school to use this module to improve student's critical thinking. Teacher can modify the module as the condition of student and environment. Furthermore, the results of this study were limited to grade 11^{th} at vocational school. We wonder in future, the researcher can develop another mathematics module for vocational school at grade $10^{th}$and 12^{th} that oriented on critical thinking development.

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