# An Integrated RME and PBL Mathematics E-Module for Vocational High School Learning: A Need Analysis

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**Abstract**
In this digital era, we can access information that we need easily. Including mathematics learning material. The are a lot if digital based learning materials that can be accessed anytime anywhere. However, the are still limited studies about developing mathematics e-modul as one of learning resources for vocational high school students. Therefore, this study investigates the need to develop An Integrated RME and PBL Mathematics E-Module for Vocational High School learning. This study is a descriptive survey involving 52 tenth grade students consist of 27 students from the Pharmaceutical Technology Expertise Field, 10 students from the Industrial Chemical Engineering Expertise Field, and 15 students from the Beauty and Spa Expertise Field, and also four mathematics teachers from four different vocational high schools with various expertise field in a city of Surakarta, Central Java, Indonesia. The data collection was conducted using printed questionnaires (for students) and online questionnaires (for teachers). The data was summarized and analyzed descriptively. Based on the data analysis, it can be concluded that there are still limited realistic problems in Indonesian mathematics textbook for vocational high school based on each expertise fields. Therefore, developing an integrated RME and PBL mathematics e-module is necessary. The characteristic of the integrated RME and PBL mathematics e-module are: (1) the e-module's content should be presented in Bahasa Indonesia, providing realistic contexts by the certain expertise field and can also be from various expertise fields; (2) the learning activities should be carried out in groups, held inside or outside the classroom and involve problems that are related to the expertise field; (3) the learning media can be in the form of electronic and non-electronic media; (4) The assessment activities can be carried out in writing or authentic assessment.
**Keywords:** e-modules, realistic mathematics education, problem-based learning, vocational high school

## Introduction

Education is an ever-evolving field that adapts to the changing times. In today's society, people are heavily reliant on technology. Both parents and young children are accustomed to using gadgets. Therefore, educators should leverage this trend to enhance student academic performance (Husaini et al., 2014; Ummah & Azmi, 2020; Zen, 2019). Information and communication technology has seamlessly integrated into the realm of education, adding excitement to the learning process and enhancing the overall quality of education (Afrizal Purba & Defriyando, 2020; Komar et al., 2022; Murtiyasa & Rahmawati, 2021).

The integration of information and communication technology into education can be achieved through the use of e-modules. Modules, which are text-based learning

materials, serve as supplementary resources to enhance student learning (Rejeki et al., 2023; Rismayanti et al., 2022). Previously printed modules can now be transformed into electronic versions known as e-modules. These e-modules not only include text but also feature images, videos, audio, and animations. With the widespread use of personal mobile phones among students, employing e-learning modules on mobile devices facilitates easier access to knowledge, particularly in mathematics subjects, both in and out of the classroom (Andhany & Maysarah, 2023; Mulyatiningsih, 2011; Nur Pasiuli Harahap, 2021).

A number of studies have been conducted on e-modules in the field of mathematics. The research of (Rismayanti et al., 2022) involved creating a kodular mobile-assisted e-module aimed at enhancing the critical thinking skills of junior high school students in mathematics. Additionally, (Rohmatullah et al., 2023) developed an interactive e-module based on problem-based learning (PBL) to enhance students' mathematical critical thinking abilities. Researchers from (Suarsana, 2013) also developed problem-solving-oriented e-modules to enhance students' critical thinking skills.

There has been previous research on e-modules based on RME. Research from (Gunawan et al., 2022) states that RME-based e-modules can improve students' mathematical connection skills. Furthermore, research from (Rodi'ah et al., 2024) produced an RME-based e-module that can improve students' understanding of concepts. Research from (Alghiffari et al., 2024) developed ethno-RME-based e-modules to strengthen students' problem-solving abilities.

Research on e-modules based on problem-based learning has also been carried out. Research from (Khasanah & Khaerunnisa, 2024) states that PBL-based e-modules can support students' numeracy literacy. Furthermore, research from (Muhammad & Fauzi, 2024) produced PBL-based e-modules to improve students' problem-solving skills and appreciation for mathematics. Meanwhile, research from (Novianti et al., 2023) produces PBL-based e-modules that can improve students' critical thinking skills. Based on the explanation above, RME and PBL are two learning models that can be integrated into mathematics e-modules to support students' learning activities. This research will focus on improving students' critical thinking skills.

RME, a mathematics learning approach invented by Freudenthal in the Netherlands in 1968, has been widely applied and developed in various countries, including Indonesia. In Indonesia, the implementation of RME is known as Indonesia Realistic Mathematics Education (PMRI) (Ningsi et al., 2024). The application of RME in Indonesia is

characterized by five main characteristics, namely the use of real-world context as an initial approach to learning, the use of models as a link between the real world and more abstract mathematical concepts, the application of student strategies to improve understanding, the involvement of interaction and collaboration between students, and the attention paid to the relationship between concepts in the learning process (Pambudi et al., 2022; Pramudiani et al., 2022).

Problem Based Learning (PBL) is a student-centered learning approach, where they are faced with a real problem to be solved (Nurika et al., 2024). Through PBL, students are encouraged to think critically, analyze problems, and find solutions using mathematical concepts (Risanti et al., 2021). This approach helps students understand the application of mathematics in everyday life, while also developing their collaboration and communication skills. Thus, PBL makes mathematics learning more meaningful and relevant for students (Herlina & Ihsan, 2020).

The explanation above shows the importance of using e-modules in mathematics learning activities. However, there is still limited research on the development of e-modules for vocational high school students, especially those that integrate the RME approach and the PBL learning model. Therefore, this study investigates the need to develop a mathematics e-module that integrates RME and PBL for mathematics learning in vocational high schools.

## Method

The type of this study is descriptive survey. Descriptive survey research is a type of study designed to describe the characteristics, conditions, or phenomena of a specific population at a given point in time. Essentially, this research aims to provide an accurate representation of a situation without altering or manipulating the research variables. The data collected is quantitative (numbers) or qualitative (words). Data analysis is descriptive, such as frequency calculations, percentages, averages, and standard deviations. Descriptive survey does not require complicated experimental design and it can collect data from various aspects (Sutama et al., 2022; Syahrizal & Jailani, 2023).

This study was involving 56 respondents. Student respondents came from SMK Muhammadiyah 4 Surakarta class X which consisted of three expertise fields. 27 students from the Pharmaceutical Technology Expertise Field, 10 students from the Industrial Chemical Engineering Expertise Field, and 15 students from the Beauty and Spa Expertise

Field. The teacher respondents were four mathematics teachers at vocational high school (SMK) in Surakarta City. One teacher came from SMK Negeri 1 Surakarta with institutional accounting and finance expertise field, marketing, office management and business services, and visual communication design. The second teacher came from SMK Murni 2 Surakarta with information and computer engineering expertise field, office governance automation, accounting and institutional finance, as well as online business and marketing. Another teacher came from SMK Muhammadiyah 3 Surakarta with expertise field in electrical installation engineering, audio video engineering, and computer and network engineering. Last teacher from SMK Bhineka Karya Surakarta with mechanical engineering and automotive engineering expertise field.

Data collection uses questionnaire sheets for students and online questionnaires for teachers. The questions from the questionnaire focused on the use of realistic context in vocational mathematics learning, the implementation of methods and models in mathematics learning activities, and the need to develop e-modules that integrate RME and PBL for vocational high schools. Two experts assessed the questionnaires in terms of face validity and content validity. The reliability of the questionnaire is determined by the reliability between graders using Cohen's Kappa coefficient.

The data obtained is then summarized and analyzed descriptively to provide an insight into the current situation regarding mathematics learning activities carried out in vocational high schools and the need for innovation to support mathematics learning activities by integrating RME and PBL outlined in the e-module. Table 1 shows the demographic conditions of the respondents.

**Table 1.** Respondent Demographics (n = 56)

| **Tipe** | | **Frequency** | **Percentage (%)** |
|---|---|---|---|
| Gender | Male | 13 | 23,21 % |
| | Female | 43 | 76,78 % |
| Role | Student | 52 | 92,85 % |
| | Teacher | 4 | 7,14 % |

## Results and Discussion

*The use of realistic context in vocational high school mathematics books*

The similar meaning questions were asked to students and teachers to investigate the use of realistic context in vocational high school mathematics learning activities. There

are five questions for students and four questions for teachers to investigate in detail about the use of textbooks or modules to support mathematics learning activities in vocational schools. Table 2 shows questions about the use of realistic context in mathematics textbooks.

**Tabel 2.** Questions related to realistic context

| Questions for students | Questions for teacher |
|---|---|
| 1. Do the math textbooks you have read already contain realistic material that suits your vocational program?<br>2. What are the real world problems contained in the math books that you have read?<br>3. What do you think if there are mathematics teaching materials whose material is adapted to your vocational program? | 1. Are the teacher books and student books provided by the Indonesian Ministry of Education and Culture contain a realistic context that is in accordance with the vocational programs available in your school? (Please describe it in detail)<br>2. What do you think if there are mathematics teaching materials whose material is adapted to the vocational program available at your vocational school? |

Of the 52 student respondents, 46% stated that there was no specific and realistic material related to the vocational program of vocational high school in the mathematics textbook book provided by the Ministry of Education and Culture. Meanwhile, all of the four teacher respondents, 100% stated that there was no specific and realistic material related to the vocational program of vocational high school in the mathematics textbook provided by the Ministry of Education and Culture.

The contextual material that has been contained in the textbook includes buying and selling related to the two-variable linear equation system, geometry, determining the distance between locations related to ratio, and real-life problems involving basic mathematical operations.

The results show that there are still limited realistic mathematics problems contained in the mathematics textbook for vocational schools with vocational programs owned by their respective schools. Previous research has stated that there are only a small number of exercise questions in mathematics textbooks that can be classified as HOTS questions. The HOTS problem with the highest number (13,11%) is found in the chapter on linear equation systems and one-variable inequality (Yenusi et al., 2019). In addition, there are only 33,38% of contextual-based questions contained in the eighth-grade mathematics textbook (Murdaningsih & Murtiyasa, 2016).

Furthermore, of the 52 student respondents, 80,76% agreed if mathematics teaching materials were developed whose material was adapted to the vocational school expertise. All of the four teacher respondents, 100% agreed if mathematics teaching materials were developed whose material was adapted to the vocational school expertise.

The findings above show the need to develop instructional learning according to the steps of RME to enrich mathematics learning activities in vocational schools. The instructional learning will provide realistic contexts and lead the teachers to implement learning activities based on the steps of RME.

*The application of learning methods and models in mathematics learning activities at vocational high schools*

Questions related to learning methods in mathematics learning activities are delivered to students while teachers are given a question about learning models that are suitable for mathematics learning activities. Table 3 shows questions about the application of learning methods and models to mathematics learning.

Of the 52 students, it was shown that the learning method that was often applied was assignment. And a method that is rarely applied is the discussion method. The results of the survey for students can be seen in Figure 1.

**Table 3.** Questions related to the application of learning methods and models

| Questions for students | Questions for teacher |
|---|---|
| In mathematics class, what learning methods are usually applied by your teachers? | In mathematics learning activities at vocational high schools, the appropriate learning model to be applied is … |

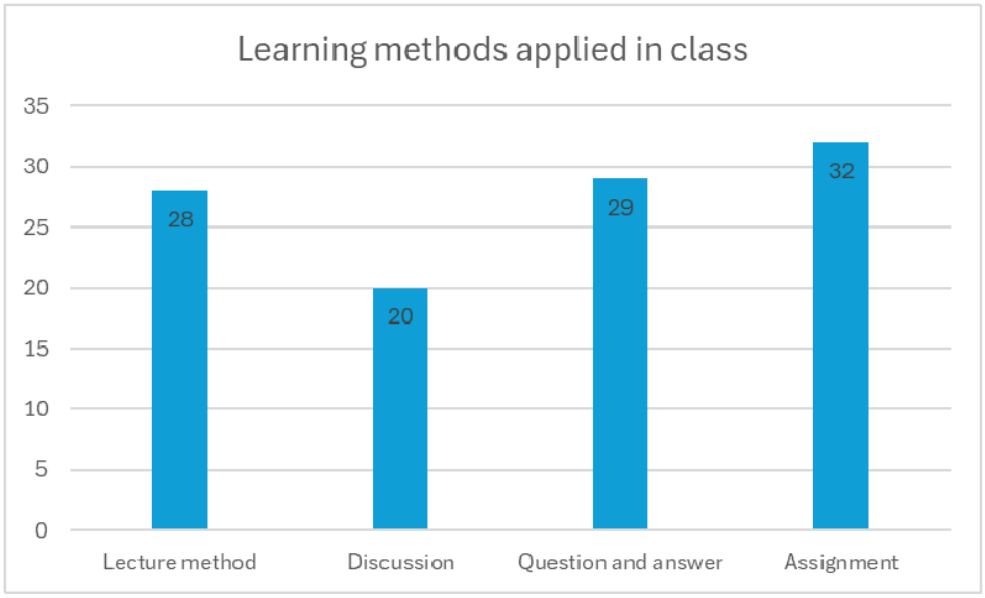


**Figure 1.** Results of student surveys regarding to the application of learning methods in mathematics class

In the *merdeka* curriculum, the *Pancasila* student profile is a form of translation of national education goals. One of the dimensions of the Pancasila student profile is *gotong royong* (mutual cooperation) (Mery et al., 2022). *Gotong royong* and discussion have a close relationship in the realization of teamwork and collaboration (Irawati et al., 2022). In discussions, participants actively participate, share ideas, and listen to other people's opinions to solve a problem (I Nengah Widiarsa, 2020). From the answers to the questionnaire of 52 students, the discussion method is rarely carried out by teachers. Therefore, discussion activities in learning can be carried out more often.

Discussions and e-modules have a mutually supportive relationship in learning activities in the digital era. After studying the e-module, the discussion becomes a means to deepen understanding, share views, and clarify material and problems that may be poorly understood. Discussions, both through online and face-to-face platforms, enrich the learning process of e-modules by involving active interaction between students and teachers (Hidayat et al., 2023; Khotimah et al., 2022; Pramana et al., 2022).

Figure 2 shows that out of 4 mathematics teachers, realistic mathematics education is a learning model that is suitable for mathematics learning activities in vocational high schools. With the RME approach, learning mathematics in vocational schools becomes more relevant and interesting for students because they learn to use mathematical concepts to solve real problems related to their vocational expertises.

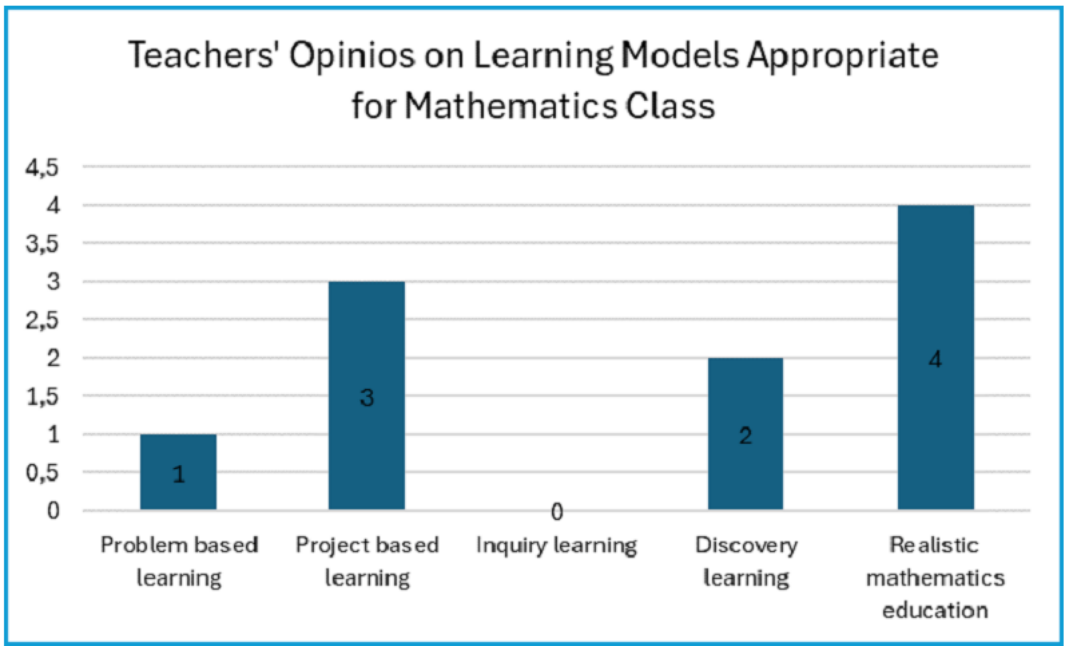


**Figure 2.** Teacher survey results regarding the application of learning models in mathematics class

*The use of E-modules in mathematics learning activities*

Questions related to the use of e-modules are delivered to teachers and students. Table 4 shows questions about the use of e-modules in mathematics learning activities in vocational high schools.

**Table 4.** Questions related to the application of e-modules

| Questions for students | Questions for teacher |
|---|---|
| 1. Have your teachers been using e-module-based learning media?<br>2. What do you think if there are mathematics learning materials that can be accessed with a smartphone anytime and anywhere? | 1. Are you currently using e-module-based learning media? Please explain<br>2. What do you think if there are mathematics learning materials that can be accessed with a smartphone anytime and anywhere? |

As many as 48.21% of the total 56 respondents stated that learning activities had used e-modules. Meanwhile, 98.21% of a total of 56 respondents agreed if there are teaching materials that can be accessed anytime and anywhere via smartphones. Therefore, e-modules are very supportive to students to be able to learn anywhere and anytime, one of which is during *Praktik Kerja Lapangan* or PKL (Field Work Practice) activities. PKL were carried out in industrial places for 16 weeks. With the e-module, students can still learn mathematics even though there is no learning activities at classroom.

*Characteristics of the e-module's components*

Questions about the characteristics of the components of the e-module were delivered to all 56 respondents. The question is "if an e-module that contains the context of RME in the material of the three-variable linear equation system will be developed, what characteristics are needed to compile the e-module? The results of the question can be seen in Table 5.

**Table 5.** Questions for e-module characteristics

| No | Aspects | Yes (%) | No (%) |
|---|---|---|---|
| 1 | E-module's content | | |
| | a. The e-module is presented in two languages, which is in Bahasa Indonesia and English | 41,07 | 58,93 |
| | b. E-modules contain mathematical problems with realistic contexts by the area of expertise of vocational high school students | 60,71 | 39,29 |
| | c. E-modules contain mathematical problems with realistic contexts from various field, not only by the area of expertise of vocational high school students | 71,43 | 28,57 |
| 2 | Learning activities | | |
| | a. Learning activities are carried out in groups | 71,43 | 28,57 |
| | b. Learning activities are carried out inside and outside the classroom | 96,43 | 3,57 |
| | c. Learning activities involve problems that are related to the expertise of students | 66,07 | 33,93 |
| 3 | Learning media | | |
| | a. Non-electronic learning media such as books, cards, or paper | 62,50 | 37,50 |
| | b. Electronic learning media such as videos, projectors, or powerpoint slides | 85,71 | 14,29 |
| | c. Manual calculation tools such as pencil and paper | 73,21 | 26,79 |
| | d. Calculator for calculation tools | 83,93 | 16,07 |
| | e. Computer-based calculation tools such as MS excel application | 46,43 | 53,57 |
| | f. Websites that can be accessed using the internet | 87,50 | 12,50 |
| 4 | Assesment | | |
| | a. The assessment is carried out by oral tests | 50,00 | 50,00 |
| | b. The assessment is carried out by written test | 94,64 | 5,36 |
| | c. The assessment is carried out based on the activeness of group discussions | 64,29 | 35,71 |
| | d. The assessments are carried out individually | 73,21 | 26,79 |
| | e. The assessment is carried out in groups | 66,07 | 33,93 |

Based on the survey results, the e-module is only presented in Bahasa Indonesia. E-modules can contain RME material from the expertise program taken by students and can also be from various expertise programs. Learning activities will be better if they are carried out in groups, held inside or outside the classroom, and involve problems that are related to the expertise program. Learning media can be in the form of electronic and non-electronic media. The assessment activities can be carried out in writing or authentic assessments.

Research on the integration between PBL and RME has been carried out by (Rustam et al., 2018), (Maslihah et al., 2021), (Kurniawati et al., 2023), and (Wardiah, 2024). However, the research that has been carried out has not been conducted at the vocational high school. Therefore, this research plays a role in producing a more detailed e-module for vocational high school students that integrates RME and PBL.

## Conclusion and Suggestion

There are still limited materials with a realistic context and learning activities based on the steps of RME in the textbooks of vocational high school students. Materials that have a realistic context have not been fully created based on the vocational school students' expertise programs. Several learning models and methods have been applied to mathematics learning at vocational high schools, namely lecturer method, discussions, questions and answers, and assignments. Meanwhile, the learning models that have been implemented are problem-based learning, project-based learning, discovery learning, and realistic mathematics education. Therefore, integrating a learning model that is suitable for vocational schools can be an alternative step to implement. In this case, it integrates RME and PBL in a mathematics e-module.

The characteristics of e-modules can be defined into four aspects. First the e-modules can contain RME material from certain expertise field and can also be from various expertise fields. Learning activities will be better if they are carried out in groups, held inside or outside the classroom, and involve problems that are related to the expertise field. Learning media can be in the form of electronic and non-electronic media. Assessment activities can be carried out in writing or authentic assessments.

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