MODULE DEVELOPMENT IN MATRIX MATERIAL USING THE INDONESIAN REALISTIC MATHEMATICS EDUCATION (PMRI) APPROACH FOR CLASS X OF SMK

Apilian Dwi Putranto[a], Aris Thobirin[b]
Program Studi Pendidikan Matematika Universitas Ahmad Dahlan
Jalan Ring Road Selatan, Tamanan, Banguntapan, Bantul Yogyakarta
[a]apprilian.putranto@gmail.com,[b]aris.thobi@math.uad.ac.id

ABSTRACT

The availability of mathematics teaching materials in some schools, for example in SMK Muhammadiyah 1 Yogyakarta is still short of available, especially the new teaching materials and the providing of convenience for students in learning. This study aims to develop and test the feasibility of the Module on matrix materials with the Indonesian Realistic Mathematics Education (PMRI) approach for Grade X Students at SMK (Vocational School). The research of module development on matrix material with Indonesian realistic mathematics education approach for grade X students at SMK follows steps Research and Development (R & D) which include: (1) potential and problem, (2) data collection, (3) product design, (4) product validation, (5) design revision, (6) product trial. Research subjects are material experts, media experts, and grade X students at SMK. The technique for analyzing data uses qualitative descriptive analysis, questionnaire. The results of this research consist of five main titles, and those are (1) understanding of matrix, (2) kinds of matrix, (3) addition and subtraction of matrix, (4) matrix multiplication, (5) Determinant, minor, cofactor, adjoin and inverse matrix. According to the research results, the material expert obtained an average score of 105.3 with perfect criteria, according to the effects of media experts, which scored 77 with complete rules. The student's response to a module is excellent, with an average score of 75 after experiment 1. At the same time, in a product test, it increases to score 76,8 of average with excellent criteria. The results indicate that the Module for the Grade X students at SMK on matrix material is feasible to use in the learning process.

Keywords: Development of Module, Matrix, PMRI

INTRODUCTION

Education is often interpreted as a human effort to foster his personality by the values in society and culture. In its development, the term education or pedagogy means guidance or help given deliberately by an adult so that he becomes an adult (Hasbullah, 2013: 1). The results of the 2015 mathematics national examination of SMK (BSNP, 2016) show that the percentage of mastery of matrix material is still relatively low. This is the background of the choice of matrix material in this study. Table 1 below shows the percentage of mastery of matrix material in one of the Yogyakarta schools, in the mathematics national examination vocational school 2014/2015.

Table 1. Rate of Mastery of Matrix Material in One Yogyakarta School, at the 2014/2015 Vocational High School National Examination

Tested Ability	School	Prov	Nat
Apply the concept of the matrix to solve problems	27,61	54,09	50,70
Determine the result of matrix operation or inverse matrix	23,66	53,42	52,26

(BSNP, 2016)

Based on the data presented in Table 1 above, it can be seen that the percentage of mastery of matrix material at the school level in the 2015 National Mathematics Vocational School for the ability of students tested determines the results of matrix operations or inverse matrices that is 23.66%. Based on researchers' observations made on October 25, 2016, at SMK Muhammadiyah 1 Yogyakarta, there is a

demand for learning problem-solving. Mathematical learning material is often abstract and complicated. This results in students having difficulty understanding. Even the teacher is also challenging for explaining; it is necessary to develop appropriate teaching materials to overcome these difficulties. The existence of proper teaching materials, complicated or abstract learning materials, can be easily solved using various media. Also, the teaching and learning process is still centered on the teacher. Teachers even often use the lecture method to teach the material, and students do not play an active role in the learning process. Teaching materials used by teachers are only limited to one teaching material used. Learning activities for students have not used teaching materials such as modules to handle students. The absence of teaching materials used by students, this is less able to arouse students to study spirit, especially in mathematics. In general, the use of teaching materials is an alternative to overcoming students' low learning outcomes, especially in mathematics. By using teaching materials in teaching, it is expected to be able to improve student learning outcomes.

Based on the second observation made on November 15, 2016, there is no module teaching material used by teachers in learning at the SMK in Yogyakarta. Teachers often use worksheet in teaching and learning activities. While mathematics and internet modules are used as reference material for making worksheet, not all the material in teaching materials is related to tangible or logical or concrete objects, which results in students not thinking logically in-class learning. Not yet able to be directed to rational thinking, education is still often abstract for students to catch; this is deep student learning because of abstractness.

Some students' expressions like learning to use modules because it is felt that with the Module, students can learn on their own before the teacher explains learning in the classroom. Modules can also facilitate and help students to understand and remember the material. By using the Module, it is hoped that students will be more comfortable to conclude and understand the subject matter delivered.

When learning in class, the teacher uses a direct and cooperative learning approach for teaching and learning activities. This learning in schools has not used the knowledge associated with something to be imagined as in the Indonesian realistic mathematics learning approach (PMRI).

Freudenthal (Ariyadi Wijaya, 2012: 20) argues that mathematics is a form of human activity underlying the development of realistic mathematics education. Practical mathematics education is an approach to learning mathematics learning in the Netherlands. The word sensible is often misinterpreted as real-word, which is the real world. Many people assume that realistic mathematics education is an approach to learning mathematics that must always use everyday problems. The use of the word practical comes from the Dutch *zich realiseren*, which means to imagine or imagine (Van den Heuvel-Panhuizen, 1998). According to Van den Heuvel-Panhuizen, the use of the word realistic does not merely indicate a connection with the real world (real-word) but rather refers to the focus of realistic mathematics education in emphasizing the use of a situation that can be imagined (imaginable) by students.

Therefore, researchers are interested in developing teaching materials on matrix material using the PMRI approach and teaching material produced in the form of modules. Modules teach elements that are arranged systematically, and interestingly that includes the content of the article, methods, and evaluations that can be used independently (Martiyono, 2012: 133). With modules, students can determine their learning abilities independently. The presentation of the material in the Module is adjusted to the principles and characteristics of PMRI, where learning is emphasized in the performance of realistic problems.

Identification of the problems includes: (1) The achievement of student learning outcomes in mathematics is relatively low. (2) Mastery of matter or absorption in the matrix material is still little. (3) Learning mathematics in schools, some are always centered on the teacher. (4) Student learning is still low due to abstract learning material. (5) Students ever do not think logically in education. (6) The absence of modules, especially interesting teaching materials through the PMRI approach.

The formulation of the problem in this study is (1) How to develop a mathematics learning module on the matrix material with the PMRI approach for grade X vocational high school students? (2) Is the mathematics learning module on the matrix material with the PMRI approach for grade X

professional students feasible to use by students?. This study aims to: (1) develop mathematics learning modules on matrix material with the PMRI approach for grade X vocational students. (2) To find out mathematics learning modules on matrix material with the PMRI approach for grade X, professional students are appropriate for students to use or not.

RESEARCH METHODS

The media development model used is the Research and Development (R&D) research method. Research and development is a research method used to produce specific products and test the effectiveness of these products. Sugiyono (2015: 407). The steps of research and development of Research and Development (R&D) methods are quoted from Sugiyono (2012: 409), namely: (1) potential and problems, (2) collecting data, (3) product design, (4) design validation, (5) design revisions, (6) product trials, (7) product revisions, (8) usage trials, (9) product revisions, (10) mass production. The following explanation of the steps of research and development by the above description:

1. Potential and Problems
   Research can depart from the potential and problems. Potential is everything that, when utilized, will have added value. And the problem, as stated, is the deviation between the expected and what happened.
2. Gather information
   This information gathering is done by conducting interviews with subject teachers in schools. The information can be used as material for planning certain products that are expected to solve the problem.
3. Product design
   Products produced in Research and Development research are various. In this research, the product to be developed is a module on matrix material with a realistic Indonesian mathematics education approach for grade X students of SMK.
4. Design Validation
   Design validation is an activation process to assess whether the product design, in this case, the new teaching method will rationally be more effective than the old one or not. For module product validation, it can be done by presenting several experts or experienced experts to assess the newly designed product. Here the intended experts are mathematics lecturers and subject teachers.
5. Product Testing
   In developing teaching materials such as modules, product trials can be given directly to students, after passing tests to material experts, and media experts, their task is to assess whether the products made are suitable for use as teaching materials or not.
6. Product Revision
   The function of this product revision is to correct the deficiencies that exist in teaching materials and improve teaching materials by the advice of experts so that the developed media can be of higher quality.
7. Trial Usage
   After testing the product successfully, then the product in the form of teaching material for the student activity sheet, the Module can be applied as teaching material on a broader scope of educational institutions.
8. Product Revision
   This product revision is carried out if there are weaknesses and weaknesses in use in a broader educational institution. In the usage test, the product manufacturer should always evaluate how the product's performance, in this case, is a module

For the assessment carried out by material experts, media experts, and student responses, an instrument in the form of questionnaires was used. The calculations were carried out using the criteria according to table 2 below.

Table 2. Module Assessment Criteria

Range of scores (i) quantitative	Category
$\bar{X} > \overline{M_i} + 1{,}8\,SB_i$	Very good
$\overline{M_i} + 0{,}6\,SB_i < \bar{X} \leq \overline{M_i} + 1{,}8\,SB_i$	Good
$\overline{M_i} - 0{,}6\,SB_i < \bar{X} \leq \overline{M_i} + 0{,}6\,SB_i$	Enough
$\overline{M_i} - 1{,}8\,SB_i < \bar{X} \leq \overline{M_i} - 0{,}6\,SB_i$	Less
$\bar{X} > \overline{M_i} - 1{,}8\,SB_i$	Veri Less

Information :

M_i : ideal average

$M_i = \frac{1}{2}$ x (Ideal maximum score + Ideal minimum score)

SB_i : *ideal standard deviation*

$SB_i = \left(\frac{1}{6}\right)$ x (Ideal maximum score − Ideal minimum score)

Ideal maximum score: Σ criteria items × the highest score.

Ideal minimum score: Σ criteria items × the lowest score. Sukarjo (2006:53)

The feasibility of this Module is determined by calculating the average value obtained from each validator, namely expert lecturers and mathematics teachers and students' responses. The average amount of each validator and student response is then matched to the module eligibility criteria with calculations that correspond to the large number of questionnaire questions made.

RESULTS AND DISCUSSION

Worksheet writing is done after the materials needed in the making worksheet have been fulfilled. worksheet characteristics for SMK students in the matrix content that will be developed are: (1) By KI, KD, and indicators of achievement that will be reviewed have been explained in the curriculum analysis above. (2) Using simple language, The first presentation for vocational students on this matrix material is presented in simple language to make it easier for students to understand. (3) Illustration of pictures, Presentation of the content, and questions are accompanied by examples of images to clarify the material and issues. Image illustration aims to attract students to be more motivated in learning and more comfortable to understand the content.

Examples of products produced:

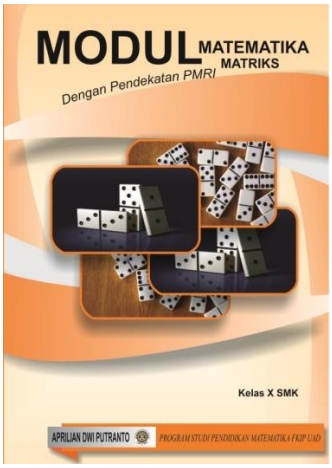

Figure 1. Front cover

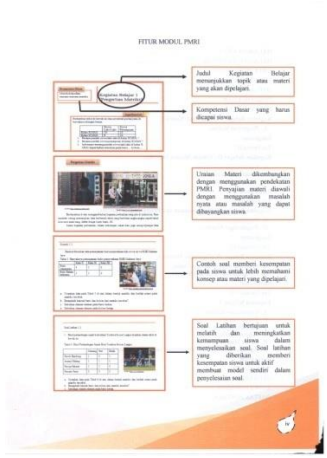

Figure 2. Content of the book

Figure 3. Content of the book

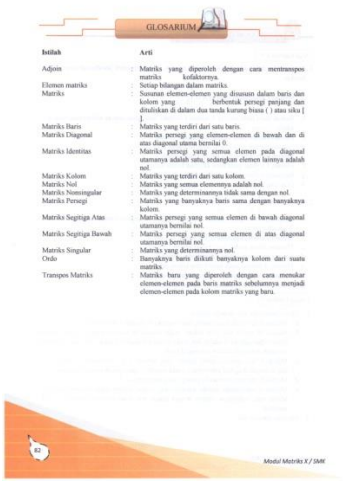

Figure 4. Content of the book

The development of this mathematical Module produces a module in mathematics learning that is suitable for students' needs for grade X vocational high school students on matrix material. The steps for developing this Module are data collection, product development, design validation, design revision, and product trials. The study was conducted in class X SMK Muhammadiyah 1 Yogyakarta dan SMK Koperasi Yogyakarta in the school year 2016/2017 with the matrix material module product with an

approach to Indonesian mathematics education. The study was conducted from April 26 to May 2, 2017. The classes used are small classes and large classes. The number of small classes is five students, and the name of the broad class is 20 students. For a small class, they were randomly selected. And for large classes, regular classes are taken. The researcher himself acts as a guide for his research net at SMK Muhammadiyah 1 Yogyakarta and SMK Kerjasama Yogyakarta. The study was conducted by giving books and questionnaires to students to read and fill in the questionnaire.

1. Material Expertise Test

   The feasibility of the module product is assessed by one material expert lecturer and two vocational mathematics teachers. The material expert in question is the UAD Mathematics Education lecturer in the field of matrices, namely Dra. Sumargiyani, M.Pd. While the mathematics teacher, Ganis Yoga Purnama, S. Pd. Who is a grade X mathematics teacher in SMK Muhammadiyah 1 Yogyakarta, Selfia Setiawati, S.Pd.Si, who is a grade X mathematics teacher in SMK Koperasi 1 Yogyakarta. The results of the calculation of the eligibility questionnaire by material expert lecturers and mathematics teachers can be seen in Table 3.

Table 3. Results of the Eligibility Questionnaire Calculation by Material experts

No	Evaluator	Total score	Qualitative Criteria
1	Material expert 1	114	Very Good
2	Material expert 2	100	Good
3	Material expert 3	102	Good
Average		105,3	Very Good

From the above table, it can be seen that the average score of the results of the assessment of the material expert lecturer and mathematics teacher is 105.3. These results indicate that the modules developed in the criteria are feasible.

2. Feasibility Test of Media Experts

   One media expert lecturer assessed the feasibility of module development products. The intended media expert lecturer was UAD Mathematics Education lecturer, Syariful Fahmi, M.Pd. The questionnaire eligibility calculation results by media expert lecturers are seen in the results of the questionnaire calculation for the feasibility of media experts

Based on the average score of the results of the assessment of media expert lecturers is 77. These results indicate that the Module developed in the criteria is feasible. After going through this stage and having made several revisions according to input from experts, namely mathematics lecturers and education practitioners, the trial process can be carried out.

a. Trial I and Student Response Product Test

After the inputs from the material experts and media experts are followed up, the Module is ready to be tested on students. The test I and Product test. In the sample of 5 students for small classes and 20 students for large classes at SMK Muhammadiyah 1 Yogyakarta and SMK Kerjasama Yogyakarta. The first trial was conducted on April 19, 2017. The product test was on April 26, 2017, and the researchers directly guided the trial process at SMK Muhammadiyah 1 Yogyakarta. The first trial was conducted on April 25, 2017. The product test was on May 2, 2017, SMK Kerjasama Yogyakarta. The results of calculating student responses in the first try and Product Test can be seen in Table 4.

Table 4. Results of Calculation of Student Response to Trial I and Product Test

No	**Activity**	**Average score**	**Category**
1	Product trials I SMK Koperasi Yogyakarta and SMK Muhammadiyah 1 Yogyakarta	75	Good
2	Product trials II SMK Koperasi Yogyakarta dan SMK Muhammadiyah 1 Yogyakarta	76,8	Very Good
Average product trial score		75,9	Very Good

Based on Table 4, it can be seen that the average score of the results of students' responses to the Module is 75.9. These results indicate that the modules developed in the criteria are feasible and accepted by students.

CONCLUSION

The research and development that has been carried out have succeeded in creating a Module on matrix material with a realistic Indonesian mathematics learning approach (PMRI) for class X vocational students consisting of 5 subtitles, namely:

1. Definition of Matrix
2. Kinds - Kinds of Matrices
3. Addition and Subtraction of Matrices
4. Matrix Matters
5. Determinants, Minor, Cofactors, Adjoin and Inverse Matrices

This research was carried out through several stages: data collection, product development, design validation, design revision, and product trials. The final result of the development process series is the creation of modules that are ready to be used in the learning process. The results of the Module assessment by the material experts obtained an average of 105.3. The results of the Module assessment by the media experts got an average score of 77, so the Module is included in the eligible criteria. In the first product trial, the results of student responses to the Module at SMK Muhammadiyah 1 Yogyakarta were 75.4 with good criteria. In SMK Kerjasama Yogyakarta scored 74.6 with good criteria so that the average score of 75 with good criteria. In the product test, the results of student responses at SMK Muhammadiyah 1 Yogyakarta scored 76.5 with perfect criteria. At SMK Kerjasama Yogyakarta, got a score of 77.1 with perfect criteria so that the average rating was 76.8 with perfect criteria. Based on the above data, the Module for Grade X vocational students on Matrix material is suitable for use in the learning process.

The mathematics module product in the matrix material with the Indonesian realistic mathematics learning approach (PMRI) for the Xth grade SMK that has been produced is expected to be utilized in the learning process to master the material. The mathematics module created is still far from perfection due to limited time and thinking ability in making the compilation. Therefore, this Module needs to be further studied and developed and tested in its entirety to be utilized by grade X vocational students. After developing this mathematical Module, it is hoped that there will be efforts to produce other modules with different and better material.

REFERENCES

Ariyadi W. 2012. *Pendidikan Matematika Realistik Suatu Alternatif Pendekatan Pembelajaran Matematika*. Yogyakarta: Graha Ilmu.

Daryanto. 2013. *Menyusun Modul Bahan Ajar untuk Persiapan Guru dalam Mengajar*. Yogyakarta: Gava Media.

Depdiknas. 2008. *Panduan Pengembangan Bahan Ajar*. Jakarta: Direktorat Jenderal Manajemen Pendidikan Dasar dan Menengah.

Hasbullah. 2013. *Dasar-Dasar Ilmu Pendidikan*. Jakarta: PT. Raja Grafindo Persada.

Sembiring. 2010. *Pendidikan Matematika Realistik Indonesia (PMRI): Perkembangan dan Tantangannya*. Jurnal IndoMS: http://repository.unib.ac.id/519/1/08.%20Effie%20Efrida%20Mukhlis.pdf.

Sugiyono. 2015. *Metode Penelitian Pendidikan (Pendekatan Kuantitatif, kualitatif, dan R&D)*. Bandung: CV. Alfabeta.

Suherman, E., dkk 2003. *Strategi Pembelajaran Matematika Kontemporer*. Bandung: UPI.

Sukarjo. 2006. *Kumpulan Materi Evaluasi Pembelajaran*. Yogyakarta: Perpustakaan Program Pascasarjana UNY.

Prastowo, Andi. 2014. *Panduan Kreatif Membuat Bahan Ajar Inovatif*. Yogyakatra: DIVA Press.