

Developing a Realistic Mathematics Education Based Learning Module on Sets Subject in Junior High School

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Submission date: 08-Mar-2023 01:07PM (UTC+0700)

Submission ID: 2031899655

File name: 125968038_1.pdf (683.88K)

Word count: 4752

Character count: 26643

Developing a Realistic Mathematics Education Based Learning Module on Sets Subject in Junior High School

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ABSTRACT

The 2013 curriculum emphasizes student activity in the learning process. Therefore, learning resources used are expected to support the curriculum. Learning resources used in schools are in the form of textbooks and worksheets which only contain a summary of material and assignments for students. This makes students demotivated to learn mathematics. This study aimed at developing a valid, effective and practical mathematics learning module based on Realistic Mathematics Education (RME). The learning module intended to make it easier for students to understand the set material. This study used the 4D method, namely define, design, develop, disseminate. The product developed was a mathematics learning module that links up students' daily experiences with mathematical concepts. The subjects involved in this study were experts including material and media experts and the students of class 7D of SMP Sapt Andika Denpasar represented by 10 students as research samples. Questionnaire on the practicality of the module used in the learning process was used as data collection techniques. Further, the data were analysed quantitatively and qualitatively. The results of the study showed that, in terms of the validity of the product developed, it was valid in the material aspect and highly valid based on the assessment of media experts. After completing the product tryout, the learning modules developed were effective and practical based on the test results and questionnaires conducted to teacher and students. Thus, the learning modules developed were ready to be used in the real learning process.

Keywords: *Module development, Realistic mathematics education (RME), Set, 4D method.*

1. INTRODUCTION

Education is a conscious and planned act to create an active learning atmosphere and process to enable students develop their potential on spirituality, self-control, personality, intelligence, noble character and skills needed by themselves, society, and nation [1]. The 2013 curriculum put forward the active role of students in the instructional process as an effort to develop one's potential and abilities [2]. In addition, instructions play a key role in realizing these efforts. Instructions is a process of interaction among students, educators, and resources in a learning environment [3].

Mathematics is a discipline taught at every level of education [4]. The nature of mathematics consists of facts, operations or relation, concepts and principles. The ministry of Education regulation No. 22/2006 has explained that the objectives of mathematics subjects taught in schools are: (a) understanding mathematical concepts, explaining the relation between concepts and its

application in flexible, accurate, efficient, and precise algorithms to solve problems, (b) reasoning on patterns and properties, performing mathematical manipulations in making generalizations, compiling evidence or explaining mathematical ideas and statements, (c) solving problems that cover the ability to comprehend problems, design mathematical models to solve the problems, as well as interpret the solutions, (d) putting ideas into symbols, tables, diagrams or other media to formulate the problems, and e) having an attitude of appreciating the usefulness of mathematics in life by building curiosity, attention, and interest in learning mathematics, as well as a tenacity and confidence in problem solving [5].

Conceptual mastery is the most important aspect in mathematics instructions. [6] states that "mathematics emphasizes concepts" which means that studying mathematics initially deal with understanding the concepts in order to be able to solve problems and apply them in real life situation. The success in learning activities is commonly measured by looking at how

students master the materials provided. Hence, learning resources are expected to support this perspective. The feasible effort to conduct is developing teaching materials like module which delivers the materials in daily language. In addition to the use of teaching materials in instructional process, to achieve the learning objectives, appropriate teaching methods and approaches need to be put into consideration. Based on the results of observations and interviews conducted by the researchers to five junior high school mathematics teachers, particularly those who teach the VII graders, it is found out that the source of learning mathematics in schools is limited to student worksheet which only contain brief materials, summaries, and instructions to complete assignments. This learning resource is viewed by the researchers to be too routine and mechanistic, causing students to get bored in learning mathematics. This also lower students' achievement. The researchers then asked whether the learning resources has successfully linked students' daily lives with mathematical concepts, and the answers from most teachers are 'no'. Further, the teachers highlight that the student worksheets used have not linked the mathematical concepts with students' daily lives, leading students to have lack of motivation.

The results of this interview are also in line with the study on "The Influence of the Use of Student Worksheets on Mathematics Learning Achievement of Seventh Graders of SMPN 2 Girisubo Gunung Kidul in Academic Year of 2013/2014" by [7] with results in finding out that the use of student worksheets method to the mathematics learning achievement of the students of SMPN 2 Girisubo Gunung Kidul in the academic year of 2013/2014 was in the less category. Taking into consideration of this findings, it is necessary to develop teaching materials in order to increase students' motivation to learn mathematics as well as to improve their achievements.

One of the learning resources that can be developed to support the instructional process is a module. Module is a medium used for independent learning since there are learning instructions that allow students to learn without any assistance of the teacher. A module contains materials that are systematically arranged and as appealing as possible to attract students' interest in learning. As pointed out by Nasution, a module can be seen as a complete unit that comprises a series of learning activities designed to assist students to achieve learning goals. In addition, a module can be used as a guide for students carrying out activities actively in learning and help directing students to insert a new knowledge that they have learned to solve math problems. Materials in the module are presented in an entertaining manner and varied with pictures to attract students' attention to use it as learning resources. According to Wena (in [8]), the main characteristic of a module is self-instruction which means it contains clear objectives by describing the achievement of the basic and standard competencies, learning materials are presented specifically and in small

units to help students learn the materials thoroughly, there are examples and illustrations that support the clarity of the presentation of the learning material, it is also added with practice questions and assignments, it is made contextually, meaning that the materials presented are related to students' surroundings, tasks, or daily activities, using simple and communicative language with summary and assessment instrument inserted. Aside from self-instruction, a module also features with recognition of learning differences among individuals, formulation of learning objectives, association, structure, sequences materials, the use of various media, active participation of students, direct reinforcement of student responses, and evaluation of the students' mastery. Therefore, all of these aspects must be covered in module construction.

In order to increase students' motivation and interest in learning mathematics, the learning materials in the module needs to be presented contextually by linking students' daily lives with mathematical concepts so that they understand that what they experience every day is actually related to mathematical concepts. This is what researchers call as Realistic Mathematics Education (RME) where in the instructional process students will be directed to relate what they observe or experience in daily life to mathematical concepts they learn. Realistic Mathematics Education is an approach to mathematics learning that emphasizes on reality and environment as the starting point of learning [9]. Furthermore, according to [10] RME stresses that reality and real experiences of students in everyday life as a starting point for learning and makes mathematics as student activity. Students are directed to think about how to solve problems that they have experienced. From this explanation, it can be concluded that RME is implemented using realistic problems as a reference in learning and students are expected to find and develop mathematical concepts through this approach.

Furthermore, students are given the opportunity to apply mathematical concepts to solve daily problems through RME approach. RME is not only expected to increase students' motivation in learning mathematics, but also provide new solutions in the learning process that is different compared to conventional teaching. The RME is more effective in the way it delivers materials presentation and also creates learning atmosphere. The materials selected as a subject of discussion in this module is about sets. Students certainly find a lot of collection of things or what mathematics refer to as sets. This is what motivates the researchers to develop mathematics learning modules with the subject of sets since it is considered as closely related to the experience of the students. With the development of a mathematics learning module with RME-based sets as a subject, students are expected to learn more independently and understand the mathematical concepts related to sets. Thus, the module developed will help students gathering new knowledge. The set of activities in the module also facilitate students

to be active in discovering the concepts learned which at the same time increase teachers' role as facilitators in accordance to the demands of learning. Moreover, this module is expected to increase students' motivation to learn mathematics which is supported by the enthusiasm and efforts of teachers. In other words, mathematics instructions will receive optimal attention from students since it involves students as the center of learning, asking them to discover a new concept, and teachers as facilitators which also influences the achievement of the learning objectives.

Therefore, solving the conceptual mastery problems of the students can be done through an approach that is oriented to daily live. It is necessary to mention that Realistic Mathematics Education (RME) is considered as the solution to solve the aforementioned problems. RME is an approach to mathematics instruction that was developed in 1971 by a group of mathematicians from Freudenthal Institute, Utrecht University in Netherlands. This approach is based on the assumption of Hans Freudenthal (1905-1990) that mathematics is a human activity [11]. RME combines what mathematics is, how students learn mathematics, and how it should be taught [12]. The RME approach emphasizes how students rediscover concepts in mathematics through realistic problem for students [13]. Using these explanations as the basis, this study aims to develop a valid, practical, and effective Realistic Mathematics Education based learning module on sets as subject for seventh graders.

2. METHODS

This study employs a Research and Development (RnD) method developed by [14] that covers define, design, development, and disseminate. The subjects of the field tryout involved 10 students of the seventh graders in SMP Sapta Andika Denpasar, who were selected based on the criteria of students' readiness to take part in the study. There are several instruments utilized to collect the data in this present study, some to mention are expert validation (material experts and media experts) to examine the feasibility of the module, questionnaires (students and teachers) to test the practicality of the use of the module, and achievement test to measure the effectiveness of the module in instructional process. Table 1 showed the guidelines for validity scores of the product.

Table 1. Guidelines for validity scores of the product

Score	Criteria
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

Next, the calculation of each item will be carried out using the formula (1).

$$P = \frac{\sum x}{SMI} \times 100\% \tag{1}$$

Notes:

- P = Validity
- $\sum x$ = Total Score
- SMI = Maximum Score

Lastly, it is important to interpret the calculation results based on aspects provided. Table 2 showed the result of validity criteria based on aspects provided.

Table 2. Validity criteria

Percentage (%)	Criteria
0 – 20	Invalid
21 – 40	Less Valid
41 – 60	Quite Valid
61 – 80	Valid
81 - 100	Highly Valid

Table 3 showed the practicality scoring guideline that is used to analyze the data.

Table 3. Practicality scoring guideline

Score	Criteria
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

Each item will further be calculated with the following formula:

$$P = \frac{\sum x}{SMI} \times 100\% \tag{2}$$

Notes:

- P = Practicality
- $\sum x$ = Total Score
- SMI = Maximum Score

Table 4 showed the result of the calculation by referring to the aspects provided.

Table 4 Product practicality criteria

Percentase (%)	Kriteria
0 – 20	Impractical
21 – 40	Less Practical
41 – 60	Moderate
61 – 80	Practical
81 – 100	Highly Practical

Table 5 showed the students effectiveness criteria that is used to analyzed the data.

Table 5. Effectiveness criteria on students

Nilai	Kriteria
$X < KKM$	Ineffective
$X = KKM$	Effective
$X > KKM$	Highly Effective

The calculation of the effectiveness of the product developed toward students is carried out by using the following formula

$$M = \frac{\sum fx}{N} \quad (3)$$

where

M = Mean Score

$\sum fx$ = Students Total Score

N = Number of Students

The category based on students score can be seen as follows:

$M < KKM$ = Ineffective

$M = KKM$ = Effective

$M > KKM$ = Highly Effective

3. RESULTS AND DISCUSSION

This study was conducted on SMP Sapta Andika Denpasar on 10 students of 7th grade who had been selected by the mathematics teacher based on the criteria of students' readiness and willingness to participate in this study. The result of this study is in form of RME based mathematics learning module for seventh graders on sets subject. This study used a 4D research and development procedure consisting of defining, designing, developing, and disseminating stage.

3.1. Defining Stage

At this stage the researchers conducted interviews with five mathematics teachers who one of them was the 7th grade mathematics teachers at SMP Sapta Andika Denpasar named I Made Satria Wiguna, S.Pd., M.Pd to explore the possibility to develop this module. From the

interview, it was revealed that the mathematics learning resources used in schools were limited to textbooks and worksheets which only contained a summary of material and assignments for students. Nonetheless, there are no learning resources that link students' daily lives with mathematical concepts and it is necessary to develop realistic-based learning resources to enrich students experience and also increase their motivation in mathematics learning. Also, RME-based modules are appropriate since it can be used as supplementary materials for both teachers and students. Thus, students not only learn from the summary of the material but also from the process within learning activities itself contained in the module. Next, the researchers also conducted oral interviews with several students from different areas and classes regarding the learning resources used. From this interview, the researchers found out that learning resources in the form of worksheets used were not motivating students to learn mathematics and that is why other type of learning resources that is varied in context and appealing are needed.

In the Define stage, the researcher conducted interviews with 5 mathematics teachers in grade VII in different schools and regions regarding the mathematics learning resources used in schools as well as interests and learning resources that link students' daily lives with mathematical concepts. From the interviews, it was found that the mathematics learning resources used so far are in the form of textbooks and Student Worksheets (LKS) which only contain a summary of the material and instructions for solving problems, and there are no mathematics learning resources that link students' daily lives with mathematical concepts. This learning resource is considered by researchers to be too routine and mechanistic, causing students to be bored and unmotivated in the mathematics learning process, this is supported by the opinion of [15] which states that the questions contained in the LKS tend to be monotonous and only train students to answer questions, ineffective without a proper understanding of the material concept.

3.2. Designing Stage

After analyzing the needs, the next step is the design stage. Some of the things that are done in the product design stage of module development are as follows:

Selection of teaching materials; Based on the initial interview on the needs analysis, the teaching materials selected in this study were RME-based mathematics learning modules which researchers considered to be the most relevant teaching materials to be used at this time and with the hope of increasing students' interest and motivation in learning mathematics.

Format Selection; The steps for compiling the product design of this module include adjusting core competencies and basic competencies. The mathematics-based learning module (RME) is made using learning that is based on realistic problems experienced and can be imagined by students in everyday life. Figure 1, Figure 2,

and Figure 3 showed the selection of the format for the mathematics learning module based on Realistic Mathematics Education (RME) in the class VII set of materials.

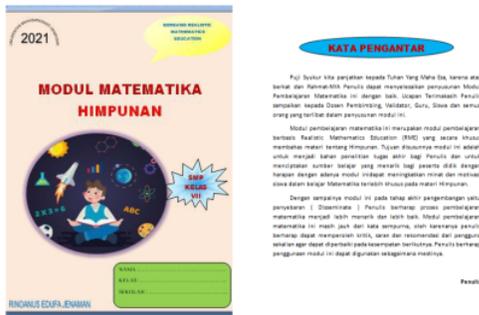


Figure 1 Cover and foreword.

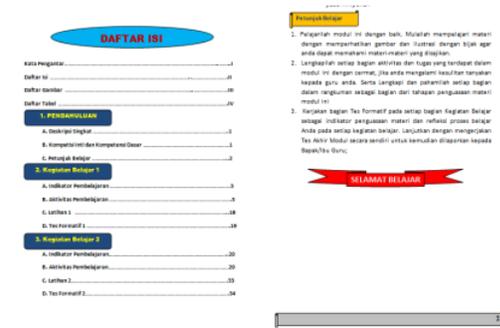


Figure 2 Table of contents and study guide.

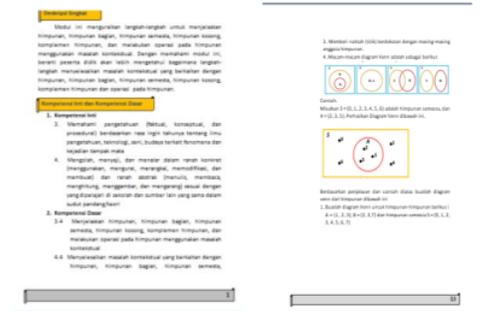


Figure 3 Core competencies, basic competencies and module content.

Initial design (initial design): This module consists of a cover, an introduction, a table of contents, study instructions, basic competencies and core competencies, material content, student activities, exercises and formative tests of group material learning activities, and are arranged based on the RME steps. The learning steps based on Realistic Mathematics Education include

understanding contextual problems, explaining contextual problems, solving contextual problems, discussing answers and concluding. However, due to several considerations between the researcher and the supervisor, this learning module does not contain a summary of the material.

3.3. Developing Stage

The development stage in this study began with expert validation (material expert and media expert). The material and media expert validator in this respect is Mrs. Putu Ledyari, S.Pd., M.Pd who is a lecturer in mathematics education at Mahasaraswati University Denpasar. Table 6 showed the results of the validation from the expert.

Table 6. Result of validity test from expert judgement on materials

Aspects	Indikator	Σx	SMI	Validitas	Kategori
Content Appropriateness	4	16	20	80%	Valid
Scope Accuracy	3	12	15	80%	Valid
RME	6	24	30	80%	Valid
Language appropriateness	3	12	15	80%	Valid
Mean Score = 80%					Valid

Based on the results of the material expert validation, it can be seen that the index of the validity test reaches 80% and can be categorized as valid. In other words, the presentation of the set materials on the developed module is feasible to be used in the research process and there is no need for fundamental revisions to the design and presentation of the developed module. Table 7 showed the validity test result from the media expert.

Table 7. Validity test from media expert

Aspects	Indikator	Σx	SMI	Validitas	Kategori
The cover and design of the module	6	25	30	83,34%	Highly Valid
Content of the module	11	45	55	81,82%	Highly Valid
Validity Index = 82,58%					Highly Valid

Based on the validity test of the media expert, it can be seen that the validity index for all aspects reaches 82.58% and being categorized as highly valid. In other

words, it can be said that the design and presentation of the developed module is feasible to be used in the research process and there is no need for fundamental revisions to the design and presentation on the developed module.

After all of the validation process are conducted, the developed product was tested in the learning process at SMP Sapta Andika Denpasar on July 28, 2021. On the other hand, the learning process was carried out online using whatsapp group and zoom meeting. After the instructional process were finished, students were given a test to determine the effectiveness of the module used. The test items have gone through a validity and reliability test. Table 8 showed the result of this test.

Table 8. Students score

No	Students Name	Final Score	Standard
1	Ida Bagus Rajendra Mahaatma Pradipta	85	70
2	Muhammad Nur Isha Putra	80	70
3	Kadek Devi Cahyani	85	70
4	Ni Nyoman Sabrina Almayra Krishna	80	70
5	Julia Nur Arini	75	70
6	Kadek Agus Satyadana	75	70
7	Ni Putu Nadia Juli Pratiwi	80	70
8	Ni Nyoman Siladhari Vasyanata	85	70
9	Muhammad Fachri Axel Defa Syaputra	75	70
10	Muhammad Kholid Maulana Akbar	75	70
Mean Score = 79,5			

Taking into consideration of the students' score above, it can be concluded that the mean score of all students who take part in the learning process using RME-based mathematics learning module reaches 79.5 whereas the standard score that the students need to fulfill is 70. Thus, since the mean score > standard score, it can be concluded that the RME-based mathematics learning module for seventh graders on sets subject is effective.

After going through the learning and testing process, the researchers administered a questionnaire to students and teachers to determine the practicality of using the learning module. Table 9 showed the results of analysis of the questionnaires.

Table 9. Questionnaire on teacher responses results

Aspects	Σ x	P	Category
Content Quality	147	73,5 %	Practical
RME	140	70%	Practical
Design and Display	138	92%	Highly Practical
Language	82	82%	Highly Practical
Mean = 79,37% = Practical			

Based on the table of the results of the teacher's response questionnaire above, the percentage of practicality of the learning modules used reaches 73% or is categorized as practical with the details of each aspect as follows: 1) Content Quality Aspects reaches 80% and is categorized as practical, 2) Aspects of Accuracy of Coverage reach 80% and categorized as practical, 3) Aspects of Realistic Mathematics Education principles reached 75% and were categorized as practical, 4) Aspects of Practicality Display reached 70% and were categorized as practical and 5) Aspects of Language Practicality reached 60% and were categorized as quite practical. And it can be concluded that the mathematics learning module based on Realistic Mathematics Education (RME) used in the practical learning process is to be used. Table 10 showed the result of questionnaire on students' responses.

Table 10. Questionnaire on students' responses results

Aspects	Indicators	Σ x	SMI	Practicality	Category
Content Practicality	3	12	15	80%	Practical
Scope Accuracy	3	12	15	80%	Practical
RME	4	15	20	75%	Practical
Design and Display	2	7	10	70%	Practical
Language Appropriateness	3	9	15	60%	Moderate

Based on the results of the student response questionnaire, it can be concluded that the learning modules used in the learning process reach an average of 79.37% practicality and are categorized as Practical for use with the following details: 1) Content Quality Aspects reach 73.5% and are categorized as Practical, 2) Aspects of Realistic Mathematics Education Principles

reached 79% and were categorized as Practical, 3) Practical aspects of Display reached 92% and were categorized as Practical, 4) Language Practicality Aspects reached 82% and were categorized as Practical. Based on the approval of the two supervisors, product trials in the development of mathematics learning modules are limited to small group trials.

3.4. Disseminating Stage

The final stage of developing an RME-based mathematics learning module for seventh graders on sets subject is dissemination. Due to the limitations that the researchers experience, the distribution of teaching materials in this study was limited to the school the study was carried out which is SMP Sapta Andika Denpasar.

4. CONCLUSION

The conclusions obtained from this research and development are: The mathematics learning module based on Realistic Mathematics Education (RME) in the class VII set material produced has been developed using a 4D stage model, namely define or defining stage, design or design stage, develop or development stage, and disseminate or dissemination stage. At the define stage, the researcher conducted interviews with 5 seventh grade junior high school teachers, then at the design stage the researcher compiled a module format design, at the develop stage there was product validation carried out by material experts and media experts, then after going through the module validation process, the modules were compiled and then tested. At Sapta Andika Junior High School Denpasar, then in the disseminate stage, the researchers distributed the modules in a limited way, which was only distributed at Sapta Andika Junior High School Denpasar. The mathematics learning module based on Realistic Mathematics Education (RME) in the class VII set material that has been developed has reached the criteria of being valid by material experts and very valid from media experts, and without the need for fundamental revisions. Furthermore, after going through the product trial process, the RME-based mathematics learning module that was developed was effective after being measured based on the KKM value set at SMP Sapta Andika Denpasar. This RME-based math learning module is also Practical. After going through the entire development process and the modules developed are Valid, Effective and Practical, the mathematics learning module based on Realistic Mathematics Education (RME) in the class VII set of materials becomes ready-to-use teaching materials.

The suggestions submitted by the researchers for the following parties: 1) For schools The development of mathematics learning modules based on Realistic Mathematics Education (RME) can be facilitated by schools so that this module can be developed even better and can increase students' motivation and interest in

learning mathematics, 2) For teachers Mathematics learning modules based on Realistic Mathematics Education (RME) can be developed and become one of the alternative teaching materials in overcoming student learning difficulties, and 3) For students, read more or use learning resources that link everyday experiences with mathematical concepts. so that students can understand that mathematics is not only about concepts but has to do with life.

AUTHOR'S CONTRIBUTION

All authors conceived and designed this study. All authors contributed to the process of revising the manuscript, and at the end all authors have approved the final version of this manuscript.

ACKNOWLEDGMENTS

We gratefully acknowledge the funding from Kementerian Pendidikan Kebudayaan, Riset, Dan Teknologi Direktorat Jenderal Pendidikan Tinggi, Riset, dan Teknologi Republik Indonesia.

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