Learning Modules Development Based on Realistic Mathematics Education in Statistical Materials

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**Abstract.** This study aims at developing Learning Modules based on Realistic Mathematics Education (PMR) on valid, practical, and effective statistical materials. This study applied Research and Development of ADDIE model. The eight (VIII) grade students of MTs (Islamic Junior High School) Madani Alauddin became the subjects and assesed them using expert validation sheet instruments, teacher and student response questionnaires, observation sheets for learning implementation, and learning outcome tests. Based on the findings, this study reveals that the development process using ADDIE development model get through five stages namely analysis, design, development, implementation, and evaluation. Through the development stage, it is produced quality products that meet the criteria of validity, practicality and effectiveness.

**Keywords**: Module, Realistic Mathematics Education (PMR)

1. Introduction

Education becomes very important and cannot be separated from life. The importance of education is considered as the benchmark for a nation's progress. Hasibuan et al. suggested that developed nations are nations that have quality of human resources which good for spirituality, intelligence, and skills. One thing can be done to achieve that goal is continuous renewal in education field [1]. Yuanita et al. also suggested that Education should supply the younger generation with important skills and knowledge [2]. It is believed that education world faces some troubles. These problems often center on students at learning difficulties. In Indonesia, learning difficulties are aimed at students who have low learning achievement. Unfortunately, there are various subjects that make students have difficulties in learning; mathematics subject is one of them.

Mathematics is a universal science that underlies the modern technology development. In order to master and create modern technologies in the future, a strong mastery of mathematics skills is required in the very beginning. Therefore, Wahyudi assumed that mathematics must be taught to students since they are in elementary school in accordance by equipping them with logical, realistic, analytical, systematic, critical, and creative thinking skills [3]. However, Ubaidillah et al. believed that some students at elementary school who are in concrete operational period getting difficulties in learning mathematics abstractly [4]. Moreover, statistics is one of difficult mathematical materials. The data are derived from observations made in grade VIII of MTs through interviews with teachers of mathematics subjects, which seems that students are only active in the process of learning mathematics if they get a task because they are worried about grades/scores and afraid of being absent. Furthermore, students get difficulties to understand the material because the available materials in school have limited only about mathematics package books and still contain abstract materials. Therefore, communicative method is required during this learning process.

Teaching materialis one of the important things on the learning process because they will provide a variety of teaching materials that can encourage students to learn. Mudlofir stated that module is a kind of the teaching material which is arranged systematically and interestingly and it is included the content of materials, methods, and evaluations used independently [5]. The module is certainly able to attract students to learn because it is presented more concisely but it is easy to be understood and it has an attrative design that can attract the students’ interestin learning.

Freudental in Wijaya [6] assumed that mathematics should not be studied as a product, but it is demanded as an activity where students can actively build their own mathematical concepts. Daryanto and Rahardjo[7] stated that teachers should use a variety of approaches, strategies, and methods in teaching mathematics to students which suit for the situation in order to fulfill the planned learning objectives. One suitable approach that is used to make students experience direct contact with their real situation namely Realistic Mathematics Education (PMR). A knowledge will become meaningful if the learning process is carried out using realistic problems or real problems that is exist in the student environment.

Sumirattana, Makanong, and Thipkong [8] stated that there are three main principles of Realistic Mathematics Education (PMR), namely guided reinvention, didactical phenomenology, and self-developed models. Guided reinvention means that students are given opportunity to experience the same process while the mathematical process is discovered which the history of mathematics can be an inspiration source. Students need to be given the opportunity to build their mathematical knowledge in learning process. Didactical phenomenology means a situation where the mathematical material provided requires investigation. Self-developed models play important role in bridging informal knowledge and formal mathematics.

Realistic Mathematics Education (PMR) is an approach that allows teachers to bring contextual problems into the classroom as the first step learning. Realistic Mathematics Education trains students to find out the concepts and encourages them to be actively involved in learning activities. Laurens et al. [9] assumed that students are required to have initiatives to solve contextual problems provided by the teachers in their own way. The use of real-world context will be more meaningful to students, as they are directly confronted with the situation that they face in their environment. Moreover, Students' learning interests will be more maximal and they want to continue studying mathematics on other problems that they may face in outside world [10]. Mathematics learning is more effective if students work actively to process and transform information[11].

Therefore, developing learning modules based on Realistic Mathematics Education (PMR) becomes one of the problem solving regarding to the limited package books and abstract mathematics subjects in order that students are more actively involve in learning process and they undergo more meaningful learning process because it corresponds to the reality of their environment. In addition, students also play important role in finding concepts, theorems, formulas, and so forth in order that the subject material will be better understood rather than they memorize theories and formulas that easily to forget.

Several studies related to Realistic Mathematics Education (PMR) have been done. These studies also developed learning tools based on Realistic Mathematics Educationfor specific materials. Putri, Hasratuddin, and Syahputra [12] conducted the research on the development of learning tools based realistic mathematics education in order to improve students' spatial abilities and motivations. It is shown that learning based realistic mathematics education meets the criteria of effectiveness and it is found that students who are classically complete ≥ 85%, the students get a minimum score ≥75. In order to achieve learning goals, positive student response and learning time are equal in regular learning. In addition, Ulandari, Amry, and Saragih [13] revealed on their research about the development of learning materials based on realistic mathematical education approaches that aims to improve the ability and self-efficacy of solving students' mathematics problems, they found that teaching materials based on Realistic Mathematics Education (PMR) approaches meet effective criteria and it can improve the students’ ability to solve mathematical problems and their self-efficacy.

Talking about the importance of Realistic Mathematics Education (PMR) in learning process as well as the importance of the use of learning modules, this article describes the development of learning modules based on Realistic Mathematics Education in statistical materials in order to measure students' learning outcomes and assess the quality of learning modules developed.

1. Method

The type of this study is Research and Development that indicates that it is a research method used to produce products and test the quality of those products. The development model used is ADDIE model which consists of five stages, namely: (1) Analysis phase, which is done to find out the students’ problems and their needs on learning process. (2) Design phase, which is done to formulate the concept of new teaching materials to be created. (3) Development phase is the stage of producing, creating or incarnating learning specifications that have been determined at the design stage and it validated learning devices. (4) Implementation phase is carried out the products trial that have been developed in learning activities. (5) Evaluation phase is carried out to make improvements to complete the modules based on the shortcomings and unmet needs of the modules that have been developed [14].

The research design in try-out product is applied only one data collection. The validity data of teaching materials is obtained through the assessment of the validator team. Practicality data is obtained through the observation of the implementation of modules on each meeting, the response questionnaire of students and teachers is given at the end of the meeting. Effectiveness data is obtained through tests of students' learning results after the learning process which the try-out design can be seen on the following flow charts.

Analysis of Students’ Needs

1. Structure the module
2. Structure other research instruments

DESIGN

ANALYSIS

1. *Develop modules & other instruments*
2. *Guidance modules & other instruments*
3. *Validation of modules & other instruments by a team of experts*
4. *Revision of modules and other instruments according to the advice of a team of experts and adviser*

IMPLEMENTATION

**Learning Module based on PMR of Statistical Materials**

1. *Testing modules in the learning process*
2. *Observing the implementation of the module*
3. *Requesting the supervision of students and teachers through a questionnaire*
4. *Conduct a study results test*

IMPLEMENTATION

1. *Analysis observation of module implementation*
2. *Analysis of students and teachers' response questionnaires*
3. *Analysis of study results test*
4. *Revise the module if it still has flaws*

EVALUATION

**Figure 1. Product Trial Design**

This trial product is limited to the eight grade students of MTs Madani Alauddin which is consisting of 10 people. Data collection instruments are validation sheets, teacher and students’ response questionnaires, module implementation observations, and learning outcomes tests. The data obtained using these instruments are then analyzed quantitatively in order to determine the validity, practicality, and effectiveness of the developed learning modules based Realistic Mathematics Education (PMR). The following table shows the data analysis techniques used to determine the validity, practicality, and effectiveness of PMR-based learning modules.

Table 1. Module Validity Criteria

|  |  |
| --- | --- |
| **Interval Score** | **Criteria** |
| 4.3 ≤ M ≤ 5 | Very Valid |
| 3.5 ≤ M < 4.3 | Valid |
| 2.7 ≤ M < 3.5 | Valid Enough |
| 1.9 ≤ M < 2.7 | Less Valid |
| M < 1.9 | Invalid |

Description:

M = $\overbar{K\_{i}}$ : find out the validity of each criterion

M = $\overbar{A\_{i}}$ : To find out the validity of each aspect

M = $\overbar{X}$: find out the validity of all aspects

Arsyad [15] on his research revealed that practicality can be measured based on the assessments from teachers and students as well as observation sheets that has been found by Syafruddin who found out the implementation of teaching materials in modules form. The following table shows the criteria of teacher and students response [16].

**Table 2. The Criteria of Teacher and Students Response**

|  |  |
| --- | --- |
| **Percentage**  | **Criteria** |
| RS < 50% | Negative |
| 50% ≤ RS < 60% | Less Positive |
| 60% ≤ RS < 70% | Positive Enough |
| 70% ≤ RS < 85% | Positive |
| 85% ≤ RS ≤ 100% | Very Positive |

Arsyad on his research stated that if the responses of teachers and students have not yet been positive which means that the revisions are required to what are being developed. The table of module implementation criteria [15] is as follows.

**Table 3. Module Implementation Criteria**

|  |  |
| --- | --- |
| **Score Interval** | **Criteria** |
| 1.5 ≤ M ≤ 2 | Entirely implemented |
| 0.5 ≤ M <1.5 | Partially implemented |
| 0.0 ≤ M < 0.5 | Not Implemented |

The effectiveness of learning module based Realistic Mathematics Education (PMR) can be revealed by looking at the Learning Results Test (THB) of students. Trianto in Majid [17] argued that in order to determine the learning completeness of students, the following formula may be applied.

$$Learning Completedness (KB)= \frac{T}{T\_{1}}100\%$$

Description:

T : Number earned by students

T1 : scores number

Table 4. Categories of Students’ Ability

|  |  |  |
| --- | --- | --- |
| **Score Percentage** | **Grade** | **Category** |
| 85% - 100% | A | Very high |
| 65% - 84% | B | High |
| 55% - 64% | C | Medium |
| 35% - 54% | D | Low |
| 0% - 34% | E | Very low |

1. Findings and Discussion

The learning module developed by researchers is a statistical learning module based on Realistic Mathematics Education (PMR). This module was developed through ADDIE development model. The stages of development of learning module based on Realistic Mathematics Education (PMR) are described as follows.

## Analysis stage

The analysis stage was conducted to find out the problems which was experienced by students based on interviews with the teacher. The use of conventional methods during the teaching and learning process made the students not interested in learning. The package books were also limited and only used while learning was in progress in the classroom. That caused only a small number of students being able to meet the criteria for completeness and improved their academic achievement. Therefore, researchers are interested in creating interesting learning modules for the students.

## Design stage

The design stage is the step to design learning modules that can attract the students. Learning modules were designed based on Realistic Mathematics Education (PMR) in order that students would find their own concepts and formulas then used their innovation in the sample questions. The learning module used illustrations in thing forms that happened in their environment. Then they could easily imagine and found out the concepts contained in the illustration. In other that, the image presented was not an animation image but it was a real image related to their environment. This learning module was designed to be used in South Sulawesi Area due to the illustrations and images related to South Sulawesi. However, this module can also be used in outside of South Sulawesi because in the glossary section, it has been described terms that only exist in the area of South Sulawesi. This learning module contained the titles, foreword, module feeds (learning readiness tests, keywords, info, formulas, summing up steps, individual or group ability tests), table of contents, basic competencies, learning objectives, concept maps using mind mapping, learning readiness tests, material descriptions, summaries, evaluations, glossaries, bibliography/reference, and writers's biography.

## Development stage

Learning modules are designed at the design stage/phase. This module consists of one chapter; statistical material with two sub-chapter namely the size of the data concentration and the data dissemination. Moreover, in learning modules, there is also the development of Learning Implementation Plan (RPP) that aimed to support the use of learning modules and other instruments in the form of teacher and student response questionnaires, and observation sheets of module implementation thathas purpose to measure practicality and test of learning results and the effectiveness of the learning modules developed.

Gafur [18] stated that this stage is the phase of creating the specifications that have been determined at the design stage. Furthermore, the validation at this stage iscarried out to measure the products validity that have been developed such as learning modules, Learning Implementation Plan (RPP), teacher and student response questionnaires, module implementation observation sheets, and study results tests. Validators advise on repairs and assess research devices that have been created on the validation sheet provided. On table 5, it displays the validators’ assessment results.

Table 5. Summary of Assessment Results by Expert Team

|  |  |  |
| --- | --- | --- |
| **Research Devices** | **Mean Scores** | **Criteria** |
| Learning Implementation Plan | 4.7 | Very Valid |
| Learning Modules | 4.4 | Very Valid |
| Teacher Response Questionnaire | 4.9 | Very Valid |
| Students Response Questionnaire | 4.8 | Very Valid |
| Module Implementation Observation Sheet | 4.9 | Very Valid |
| Learning Outcomes Test | 4.9 | Very Valid |
| **Total Mean Scores of Instrument Validity** | **4.8** | **Very Valid** |

On table 5, it shows that learning implementation plan (RPP), learning modules, teacher and student response questionnaires, module implementation observation sheets, and tests of learning outcomes are in ‘very valid’ category because the average aspect scoring of each research device is 4.8 at intervals of 4.3 ≤ M ≤ 5. Moreover, the first validator concluded that this research device could be used without revision and the second validator concluded that this research device could be used with minor revisions. These indicate that learning implementation plan (RPP), learning modules, teacher and student response questionnaires, module implementation of observation sheets, and learning outcomes tests are worth using at the implementation stage*.*

## Implementation stage

The implementation phase was carried out after this research device was valid and ready for learning process. This trial was conducted via online through the zoom application. Researchers conducted the limited trial of MTs Madani Alauddin that involving 10 students. The implementation stage was conducted into two meetings and the learning process on each meeting is observed using the observation sheet of the implementation of learning. At the end of the trial, a test was given to reveal the learning outcomes of the students. Moreover, response questionnaires were given to teachers and students to find out their responses toward the learning modules based on Realistic Mathematics Education (PMR) that have been developed.

## Evaluation stage

At this evaluation stage, it is obtained the dataabout the practicality and effectiveness of learning modules developed. The practicality of learning modules based on Realistic Mathematics Education (PMR) developed is known through teacher and student response questionnaires and module implementation observation sheets. The effectiveness of the learning modules developed can be known through the study test results which were conducted at the end of the learning.

Teacher response questionnaires are given to them when the learning process is complete. The results of the teacher response analysis are known that the average percentage of teacher responses to learning modules based on Realistic Mathematics Education (PMR) is about 90% which is at intervals of 85% ≤ RG ≤ 100% which indicates very positive. Furthermore, the students response questionnaire showed the average percentage of responses from ten students is about 85.31% which is at intervals of 85% ≤ RG ≤ 100% which indicates very positive. By looking at the percentage of teachers and students’ responses, the learning modules based on Realistic Mathematics Education (PMR) are practical used in learning process.

Based on the analysis results of the module implementation, it is obtained the information that there are three aspects observed namely syntax, social interaction, and reaction principle that show the average aspect of syntax which is 1.5 which is at intervals of 1.5$\leq $ M $\leq $2 which means the criteria on the syntax aspect are implemented entirely. The average aspect of social interaction is 1.25 which is at intervals of 0.5$\leq $ M $\leq $ 1.5 which means the criteria on the aspect of social interaction are only partially implemented. This is because the learning process conducted online through the zoom application causes difficulty in the implementation of group activities because the students are only in their own homes. The average aspect of the reaction principle is two which is at intervals of 1.5 $\leq $ M $\leq $ 2 which means the criteria on reaction principleaspect are carried out entirely. Thus it can be concluded that learning modules based on Realistic Mathematics Education(PMR) are practical to use in learning process.

The learning outcomes test is conducted through WhatsApp Group due to the specified time. The study test consists of 10 multiple choice questions and five essay questions. The following are the data on the descriptive analysis of the students’ test scores in grade VIII of MTs Madani Alauddin after using learning modules based on Realistic Mathematics Education (PMR).

**Table 6. Frequency Distribution and Percentage of Learning Outcomes Achieved Using PMR-Based Learning Modules**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Interval** | **Grades** | **Categories** | **Frequency** | **Percentage** |
| 85- 100 | A | Very high | 5 | 50% |
| 65 – 84 | B | High | 5 | 50% |
| 55 – 64 | C | Medium | 0 | 0% |
| 35 – 54 | D | Low | 0 | 0% |
| 0 – 34 | E | Very Low | 0 | 0% |
| **Total** | **10** | **100%** |

On table 6, it shows that there are 50% of students' learning outcomes in ‘very high’ category and 50% of others gain ‘high’ categories. The data of the students’ completeness are presented on table 7.

Table 7. The Description of Students’ Learning Achievement Completeness

|  |  |  |  |
| --- | --- | --- | --- |
| **Score** | **Category** | **Frequency** | **Percentage** |
|  $\geq $75 | Complete | 8 | 80% |
|  < 75 | Incomplete | 2 | 20% |

Table 7 indicates that there are only 2 students from 10 students who are in ‘incomplete’ category which causes that the percentage of completion only reaches 80%. Thus, it can be concluded that the mastery of the students’ learning outcomes tests still meets the standards of completeness and the learning modules based on Realistic Mathematics Education are effective to use in learning process.

Based on the validation results by the expert team, math teacher responses, the eight grade students responses of MTs Madani Alauddin, observation on modules’ implementation by the observer, and the learning outcomes tests toward students, it is proven that the learning modules based on Realistic Mathematics Education (PMR) for the 8th grade students of MTs Madani Alauddin about static materials are feasible in learning activities based on aspects of validity, practicality, and effectiveness. This is in line with the previous research findings that learning devices based on Realistic Mathematics Education (PMR) fulfill valid, practical, and effective criteria and they can improve students' spatial abilities and learning motivations [12], problem solving and self-efficacy skills [13], learning independence [1], the students’ skills [19], and mathematics learning outcomes [3]. If it is compared to conventional learning, students' achievement and reasoning skills in mathematics learning with Realistic Mathematics Education (PMR) are better than conventional learning [20].

1. Conclusion

Based on the research findings, it is obtained that the development process using ADDIE development model have been conducted through five stages namely analysis, design, development, implementation, and evaluation. Through the development stage, it is produced quality products that meet and fulfill the criteria of validity, practicality and effectiveness. The implications of this study suggest that the learning modules based on Realistic Mathematics Education (PMR) that have been developed should be expanded to be more effective and meaningful. It will indirectly improve the mathematics of students’ learning outcomes, especially in statistical materials.

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