Developing Learning Model Base On PMR Approach at Senior High School to Improve Student’s Motivation

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Abstract. There are several factors that cause the low achievement of students' mathematics learning outcomes in several senior high schools in the Dharmasraya district, the main factor is many students have difficulties in solve mathemathic problems in their daily life, that caused the low of students achievement of students, including daily assessment and national assessment. The purpose of this research is for developing learning model base on realistic mathematic education (RME) approach. Developing learning model on topic Implementation of sequences and series based on RME is an effort for helping students in solving mathematics problems that they find in their daily life. The subject of this research is students grade XI of SMAN 1 Koto Salak. The method of this research used is design research using the Plomp development model. The techniques of data collection implemented using observation, questionnaires and assessment of mathematical test. The techniques of data analysis used are descriptive quantitative and quantitative. The results of this research showed that the learning design with topic Implementation of sequences and series based on PMR approach has; the average value of HLT validity is 4.11 with a very valid category. The practical test of learning books applying PMR-based sequences and series by teachers and students is 85.02 and is classified as very practical. The average value of students' motivation in learning after being tested 83.3 and it means PMR approach also can improve student’s motivation in mathematics learning.

1. Introduction
An effective learning process is a learning process that can involve students in learning effectively too. So, for effective teaching, several teacher skills are needed, including: 1) In presenting lesson material to students, the teacher needs to provide problems that can stimulate students to think and bring up their reactions, 2) All lessons given to students need to be integrated, so that students have integrated and inseparable knowledge, 3) Lessons in school need to be linked to real life in society, 4) In
teaching-learning interactions, teachers must give a lot of freedom to students to be able to investigate themselves, learn on their own, find solutions to their own problems.

Effective learning is also greatly influenced by learning devices, teaching materials, the media used, the availability of resource books for students, the way teachers design learning, including the use of learning models during learning. The learning process is a system that has a considerable influence in achieving the standard implementation of the educational process, in order to improve the quality of education. Like what Hattie wrote (in Eggen and Kauchak, 2012)[1] that good teaching is the most important factor in student learning, good teaching is more important than curriculum, classroom arrangement, peers, funding, school and class size, and head schools, therefore the mathematics learning process should not only train routine skills, but also improve on things that emphasize conceptual understanding, intact intelligence in high-level thinking, critical thinking, divergent, analytical, synthesis and evaluative.

Students' understanding of mathematics material is closely related to the achievement of their test scores. The acquisition of mathematics scores of students, especially high school (SMA) level students is generally still low, this can be seen from the achievement of the results of the national exam (UNBK) of students at SMAN Kabupaten Dharmasraya.

There are many factors that cause the achievement of students become low, the results of the author's observations in several high schools in Dharmasraya district, some of these causes include: 1) this learning approach is dominated by the presentation of teacher-centered mathematics problems, this makes students tend to be more passive and only practice basic math skills (mathematical basic skills) are limited. 2) If it is seen from the student's point of view, of the several classes that the author observes, generally from 32 students, on average only 15.6% of students like mathematics, 34.4% of students choose neutral and the rest choose not 84.4% of students consider mathematics to be difficult, 3) in terms of material and learning media, generally mathematics material in high school tends to be more abstract, with minimal media that can be used in learning.

By this condition, mathematics learning must change the image of all aspects that make it unpopular with students. Mathematical learning that is mechanistic and monotonous must be a fun humanistic learning, mathematics learning begins with solving problems that are reality in nature (realistic mathematics), because by working on mathematical problems that are known and take place in real life, students build concepts and understandings with instincts, instincts. , power of reason, and known concepts.

They form their own structure of mathematical knowledge through the help of the teacher by discussing alternative answers. In this case the most effective answer is expected, without neglecting other alternatives. In addition, a teacher needs to continue to hone his ability to manage the active learning process, a learning model that is adapted to the material to be presented, a learning model that can relate the material to the realities of everyday life faced by students or make mathematics material realistic or solve problems in life. studenteveryday.

Permendikbud No. 22/2016 states that to strengthen this scientific approach, it is necessary to apply inquiry / discovery learning based learning. Besides the scientific approach, other learning models can also be applied, namely project base learning and problem base learning.

The problem-based learning model is a problem-based learning approach, where students are invited to solve problems related to the learning material being studied at that time, and it is suggested that learning should begin with the introduction of contextual problems, namely problems that are around students. In mathematics learning, the learning approach that is in accordance with the contextual philosophy is the Realistic Mathematics Education (PMR) approach, which is a learning approach that solves realistic problems in students’ daily lives. The PMR approach was developed in the Netherlands, based on Freudenthal's philosophy (1973)[2]which states that mathematics is a human activity, and all elements of mathematics in everyday life must be utilized for learning mathematics in the classroom.

In addition to mathematizing problems from everyday life (mathematize of everyday experience), students are given the opportunity to mathematize concepts, notations, models, procedures, operations
and solving other mathematical problems. As a human activity, mathematics material must be discovered by students themselves.

Based on the description above, researchers are interested in conducting research that aims to help students overcome learning problems by developing learning models in mathematics subjects with the PMR approach, equipped with teacher manuals and student books. For this reason, a study entitled "Development of a Mathematics Learning Model with a Realistic Mathematics Education Approach for Senior High Schools" was conducted as a solution to solving students' mathematics learning problems.

2. Material and Methods

Basically, contextual learning is a learning method that can help teachers to relate the material being studied to real life and motivates students to relate the knowledge they get to their daily lives. Nurhadi (2004) states that contextual learning is a concept of learning in which the teacher can bring the real problems of their world into their classroom and encourages all students to make many connections between their knowledge and its application in their daily lives. Thus it can be concluded that contextual learning is a learning method that can motivate many students to connect the knowledge they get from the learning process with their daily lives, which is useful for them to solve a problem in their surrounding environment. So that the learning obtained by students is more meaningful.

Contextual learning has several components that underlie the implementation process in learning. Johnson, in Nurhadi (2004) states the main component in the contextual learning system. The components are as below.

1) Have a meaningful relationship. Students able to organize themselves well in learning and develop their interests individually or in groups, and students are people who can learn by doing.

2) Doing significant activities by means of students making connections between schools with various contexts in real-world life, as members of the community.

3) Learning by Self-regulated. Students can do significant work for the purposes of having dealings with other people, have to do with making choices, and there are products or results that are tangible.

4) Working together. Students can work together effectively in groups. Meanwhile, the teacher can help students understand how they influence and communicate with each other in their groups.

5) Think critically and creatively. Students can use higher levels of thinking critically and creatively including analyzing, synthesizing, solving problems, making decisions, and using logic and evidence.

6) Nurture or nurture students' personal. Students maintain their personality by knowing, paying attention, having high expectations, motivating and strengthening themselves. Students cannot succeed without adult support. Students respect their friends and adults.

7) Reaching high standards. Students recognize and achieve high standards by identifying goals and motivating students to achieve them. The teacher's role is to show students how to achieve success in learning.

8) Using academic knowledge in real-world contexts for a meaningful purpose.

The learning model is a pattern or plan that we can use to design individual teaching patterns in the classroom, and help them to determine the materials of learning/tools including text of books, types, films, media, programs computers, and the curriculum (long-term learning plans). Each model directs us to design lessons that can help students achieve various goals. As Joyce (2009) argues that teaching model can be used to design teaching in classroom or tutorial setting by face to face method and to shape instructional material including books, films, tapes, computer mediated programs, and curricula (longer courses of study). Each model guides us as we design instruction to help student achieve various objectives.”
PMR is stand for Pendidikan Matematika Realistik or known by realistic mathematics education (RME) is basically used of reality of students life and they understand to accelerate the learning process of mathematics so as to better achieve the goals of mathematics education, where reality is real or concrete things that can be understood or observed by students through imagining, while what is meant The environment is an environment where students are in the school, family and community environment that can be understood by students. This environment is also called the daily life of students.

In Indonesia, PMR is implemented in stages in schools led by Indonesian Realistic Mathematics Education (PMRI) under the auspices of the Development Institute of Indonesian Realistic Mathematics Education (IP-PMRI). The main mission of IP-PMRI is to make better the quality of education especially ini mathematics in Indonesia by applying an innovative approach to education of mathematics that called RME.

From the above explanation, it can be concluded that PMR is an adaptation of RME which was originally developed in the Netherlands and in Indonesia it is called realistic mathematics education (PMR). PMR makes students feel abstract mathematics into something that is reality and learning become meaningful (meaningful learning).

De Lange (1987)[3] state that the mathematical concepts and ideas was processed and developed which starts from real world, it can be seen in Figure 1 below:

![Figure 1. Conceptual mathematization](image)

Contextual problems is uses by PMR as a beginning in learning mathematics. It should be noted that something that is contextual in the environment of students in one area is not necessarily a context for students in other areas. The example of talking about trains is a context for students in Java, but it is not necessarily the context for students outside Java. Therefore, learning mathematics with a realistic approach must be adapted to the conditions of the area where students are located.

Based on model development of Plomp (2010), the literature review is an activity both at the stage of preliminary research. Review back (review) literature on theories and concepts that have been conducted, showing that it takes some of the theories and concepts to reconstruct the learning model based on the PMR approach in Senior high school shown in Table 1.
Table 1. Summary of Developing Model Base on PMR approach in senior high school

| NO | Stage of Development | Activity | Activities Performed |
|----|----------------------|----------|----------------------|
| 1  | Preliminary Research | Need and context analysis | Analyze characteristic of Teachers, Analyze of Student’s characteristic, Analyse the aim of lesson of mathematik |
|    |                      | Review of literature | Analyze the theory and concept about RME |
|    |                      | Development of conceptual and theoretical framework for the study | Design a conceptual framework for the study of the development |
| 2  | Prototype (Prototyping Stage) | Design prototype | Designing a model of learning mathemathickts base on PMR approach |
|    |                      | Formative Evaluation | Doing test of Validity by expert and practitioner about prototype |
|    |                      | Revision | Revise the prototype based on the result of Formative evaluation |
| 3  | Assessment Stage | A Summative evaluation | Doing the test of practicalities and effectiveness of the prototype |
| 4  | Systematic Reflection and Documentation | Reflection | Arranging and refinement of prototype |
|    |                      | | Design new theories and concept base on the result of research |

Based on the procedure of development of Plomp (2010) the form of the activities in this research is carried out after adapted to the needs of research can be seen in Table 2.

Table 2. The Development Phase of Mathematics Learning Model base on PMR Approach (plomp 2013)[4]

| Theory and Materials | Writers |
|----------------------|---------|
| Contraction Model    | Joyce and Weil (1992) |
| Development Model    | Plomp (2010) |
| PMR Approach         | Freudhental (1992) |
| Learning Process Base on PMR Approach at SMA | Gravemeijer, 1994 |
This research is a research and development. The development model used is the Plomp development model. This model was chosen because of its practical steps and suitable for developing a learning model based on the PMR approach. (Plomp, 2013) suggests that in general there are three stages in the development of a learning model, namely the initial research stage, the prototype making stage.

This research is used the development model by Plomp which consists of 3 stages of development, 3 stages are: 1) Preliminary, 2) Protoyping, and 3) Assessment. Formative evaluations carried out are to observe the quality of development of learning models’ result based on PMR approach. The formative evaluation process carried out is formative evaluation by Tessmer[5].

![Formative Evaluation Diagram]

**Figure 2.** Formative Evaluation of Learning Model Development based on PMR approach (Modified from Tessmer, 1993)

### 3. Results and Discussion

#### 3.1. Product Validation Results

HLT, teacher's books, and student books are validated by 7 validators. HLT is validated from the aspect of content and language aspects. Teacher books and student books are validated in terms of content, language, presentation and appearance.

| No | Indicator     | Average | Category |
|----|---------------|---------|----------|
|    | Teacher and  |         |          |
|    | Student’s    |         |          |
|    | HLT Book     | HLT     |          |
| 1  | Content      | 4.17    | Very     |
From the Table 3 above, it’s known that the overall value of HLT validity is 4.11 with very valid category. The teacher book’s validity is 4.07, it means the category of teacher’s book is very valid. The validity of student books as a whole is 4.07, it means the category of student’s book is very valid. It can be concluded that HLT, teacher’s book, student book by PMR approach designed are very valid.

Table 4. Implementation Of Product Trial Test

| Meeting | Theory                                      |
|---------|---------------------------------------------|
| 1       | Arithmetic Sequence and Series              |
| 2       | Geometry Sequences and Series               |
| 3       | Sequence and Series Application: Single Interest |
| 4       | Sequence and Series Application: Compound Interest |
| 5       | Sequence and Series Application: Annuity    |
| 6       | Sequence and Series Application: Growth and Decay |

3.2. Product Practicality Results
The practicality of learning design data on the topic of applying PMR-based sequences and series was obtained from the teacher questionnaire, student questionnaire, and observation in the class room.

Table 5. Results Of The Learning Design Practicality

| Practicality Stage (%) | Assessment Aspects | Average (%) |
|------------------------|--------------------|-------------|
|                        | Instruction        | The ease    |
| One to one             | 85.80              | 84.20       | 87.20       | 88.60       | 84.20       |
| Small Group            | 84.20              | 87.20       | 85.80       | 87.20       | 82.80       |
| Field Test             | 87.20              | 82.80       | 84.20       | 85.80       | 87.20       |
| Total                  | 257.20             | 254.20      | 257.20      | 261.60      | 87.20       |
| Average                | 85.73              | 84.73       | 85.73       | 87.20       | 84.73       |

From Table 5 above, it is known that average obtained is 84.73 and classified as very practical. In other words, the learning book for applying PMR Approach-based sequences and series can be categorized as very practical.

Table 6. Results Of Practical Test Learning Learning Application And Line-Based Pmr According To Teachers

| Assessment Aspects | Average (%) |
|--------------------|-------------|
| Instructions for use | 90.00       |
| Ease to use        | 83.30       |
Based on Table 6 above, it is known that the average value of the practical test books on learning books applying PMR-based sequences and series by teachers is 85.30 and classified as very practical. In other words, the learning book for applying PMR-based sequences and series is categorized as very practical.

3.3. Product Effectiveness Test Results.
The results of students' mathematical reasoning ability tests are analyzed statistically. Overall the results of students' reasoning ability on the topic of applying lines and sequences after using the developed learning design.

Table 7. Results Of Mathematical Study Ability Test

| Indicator                                                      | Percentage |
|---------------------------------------------------------------|------------|
| Determine the pattern of mathematical symptoms to make generalizations | 59.99      |
| Provide an explanation using facts, properties               | 60.61      |
| Doing mathematical manipulation                              | 100        |
| Compile and test the conjecture                               | 69.70      |
| Describe logical conclusions about a number of ideas and their interrelations | 95.46      |
| Average                                                       | 76.97      |

From Table 7 above, it can be seen that the average value of students' mathematical reasoning ability tests after testing is 76.97%. This means that learning tools developed can be categorized into effective categories.

Overall validity of HLT results is 4.11. In terms of content and language validity for HLT it is already valid, so that this HLT can be used as a teacher's guide in carrying out PMR-based learning. The validity of teacher's book is 4.07. This shows that the teacher book has been designed and fulfilled the valid criteria. The value of the validity of student books as a whole is 4.07. This shows that the student book that has been designed has met valid criteria. Validity can be interpreted with accuracy, truth, validity or validity. Validity refers to the level of intervention design based on state-of-art knowledge and the various components of an intervention related to one another [6].

In assessing the practicality of this device, data is collected through observing the implementation of learning and practicality questionnaires filled out by students and teachers. For the implementation of learning using HLT, teacher books and PMR-based student books show that the learning process creates a classroom situation that encourages students to ask questions, answer and express opinions and interactions between students to find concepts that exist in the topic of sequences and sequences. Practicality refers to the level that users consider interventions to be used and liked by both teachers and students under normal conditions [6]. To measure the level of practicality, it can be done by considering that the material is easy and can be used by lecturers and students [7].

3.4. The Motivation Result
The results of students' mathematical reasoning in motivation are analyzed statistically. Overall the results of students' reasoning motivation on the topic of applying sequences and series after using the developed learning design.
Table 8. Results Of Motivation Mathematics Learning

| Indicator                             | Not PMR Approach | PMR Approach |
|---------------------------------------|------------------|--------------|
| Elaborate the Problems                | 74.2             | 81.8         |
| Persevering Solve Realistic Problems  | 62.1             | 83.3         |
| Enthusiastic                          | 60.6             | 75.8         |
| Working Autonomously                  | 68.2             | 80.3         |
| Average                               | 66.275           | 80.3         |

Figure 3. Result of Motivation Mathematics Learning

Evaluation of students’ mathematical reasoning abilities is done by giving tests of mathematical reasoning abilities after learning using HLT, teacher books and PMR-based student books. Based on data analysis, there is an achievement of mathematical reasoning ability of students with a categorical success and very successful. The result of this research are HLT, teacher's book, and PMR-based student book are very effective in helping students construct concepts on the topic of application of sequences and series and can improve student’s motivation in mathematics learning.

4. Conclusions
The results of this research and discussion can be concluded as follows:
1. The learning design of the topic The application of sequences and series based on PMR has been produced with the development of the Plomp model.
2. Design learning topics The application of PMR-based sequences and sequences has;
   The average value of HLT validity is 4.11 with a very valid category. Furthermore, the overall validity value of teacher's books is 4.07 with a very valid category. Furthermore, the overall value of student book validity is 4.07 with a very valid category.
   The practical test of learning books on the application of sequences and series based on PMR by teachers was 85.30 and classified as very practical. Furthermore, the practice value of learning books on the application of sequences and series based on PMR by students amounted to 84.73 and is classified as very practical.
   The average value of students' mathematical reasoning ability tests after being tested is 76.97% and can be categorized as effective.
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