Developing Learning Model Based on the PMR Approach to Improve Student’s Knowledge in Mathematics Learning

Nur Azizah¹, Ahmad Fauzan², Lufri³, Made Arnawa⁴

¹,²,³,⁴ Universitas Negeri Padang, Padang, Indonesia

* nurazizah0774@gmail.com

Abstract: There are several factors that cause the low achievement of students' mathematics learning outcomes in several high schools in the Dharmasraya district, including: learning process plans (RPP), monotonous methods, only 15% of students who like mathematics, abstract material, lack of media, teacher’s difficulty in analogizing material into life around students or vice versa. This is a Research and Development that uses the Plomp development model, which consists of three phase the Preliminary, Prototype, and Assessment. Based on the results of this research that the learning design 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' mathematical reasoning ability tests after being tested is 76.97% and can be categorized as effective and it also can improve student’s knowledge in mathematics learning.

Keyword: Learning Model, PMR Approach, Student’s Knowledge, Mathematic, Learning

1 Introduction

Mathematical Realistik (PMR) or Realistic Mathematics Education (RME) is an approach to learning mathematics which was introduced since 1970 in the Netherlands, and continues to grow to various parts of the world. [1]. RME has been developing in Indonesia since almost 20 years ago, and since then PMRI has become a widely used approach in learning mathematics [2]. RME offers a solution to overcome problems in learning mathematics, because the approach is done contextually so students are more active in thinking. The process of developing mathematical concepts begins from the real world (outside world) and ends by reflecting on the solutions obtained to the outside world again [3], [4], [2].

PMR approach using three principles of RME, namely: a) guided reinvention and progressive mathematizing, b) didactical phenomenology, and c) self-developed models. Contextual questions direct students to form concepts, develop models, apply concepts that students have been known before, analyze and finish all contextual problems by mathematical rules that apply progressively [5]. PMR characteristics are: 1) The dominating place of context problems 2) The broad attention paid to the development of models 3) The contributions of students by means of own productions and constructions 4) The interactive character of the learning process; and 5) The intertwine of learning strands [6] [7].

Many factors cause the low achievement of student mathematics learning result in several high schools in the Dharmasraya district, some of these causes include: First, when viewed in terms of the
design of the learning process plan (RPP) is dominated by the teacher-centered systems. Second, when viewed in terms of learning methods, generally mathematics teachers who are observed use learning methods that are information discussions, lectures, and class discussions. Third, when viewed in terms of students, from several classes that the authors observed, generally from 32 students, on average only 15.6% of students liked mathematics. Fourth, when viewed in terms of learning material and media, generally mathematics material in high school tends to be more abstract, the lack of media that can be used in learning, except for certain materials such as the introduction of building space, the medium of which can be made by the teacher or the student group's task, or on statistical material and contextual issues related to arithmetic and geometric sequences and sequences.[8][9] While abstract material such as functions, integrals, and limit functions, there are not many media that can be used in learning.

2 Methodology

The research was conducted at SMAN 1 Salak City, in 2019. This research was a research and development. This research is used the development model by Plomp which consists of 3 stages of development, they are 1) Preliminary Research, 2) Protoyping Phase, and 3) Assessment Phase.[10][11] This model was chosen because the steps are practical and suitable for developing learning models based on the PMR approach [12]. Formative evaluations carried out are to observe the quality of the development of learning models’ result based on the PMR approach.[13] The formative evaluation process carried out is formative evaluation by Tessmer [12].

![Formative Evaluation of Learning Model Development based on PMR approach (Modified from Tessmer, 1993)](image)

3 Results and Discussions

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 Book | Teacher’s Book | Student Book | Teacher’ s Book | Student Book |
| 1  | Content            | 4.17    | 4.00     | 4.05     |
From the table above, it’s known that the overall value of HLT validity is 4.11 with very valid category. The value of teacher book’s validity is 4.07 with very valid category. The validity of student books as a whole is 4.07 with a very valid category. It can be concluded that HLT, teacher’s book, PMR-based student book that are designed are very valid.

Table 2. 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 |

Product Practicability 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 classroom.

Table 3. Results of The Learning Design Practicability

| Practicality Stage (%) | Assessment Aspects | Average (%) |
|------------------------|--------------------|-------------|
|                        | Instruction        | The ease    | The benefits | Performance | Language |
| 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 3 above, it is known that average obtained is 84.73 and classified as very practical. In other words, the learning book for applying PMR-based sequences and series can be categorized as very practical.

Table 4. Results of Practical Test Learning Application and Line-Based PMR According to Teachers

| Assessment Aspects | Average (%) |
|--------------------|-------------|
| Instructions for use | 90.00       |
| Ease to use         | 83.30       |
| The benefits        | 83.30       |
| Performance         | 83.30       |
| Use of Language     | 86.60       |
| Average             | 85.30       |

Based on table 4 above, it is known that average value of the practical test books on learning books applying PMR-based sequences and sequences 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.

**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 5. 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 5 above, it can be seen that 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 has 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 for its characteristics meets 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 [14].

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 [14]. 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 [15].

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.

**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.

References

[1] K. Gravemeijer, Developing Realistic Mathematics Education, Freudentha. Utrecht, 1994.
[2] Seels, B. and R. Barbara, and C. Rita, Instructional Technology: The Definition and Domains of Field. Bloomington: Association for Education Communications and Technology, 1994.
[3] A. Fauzan, Applying Realistic Mathematics Education (RME) in Teaching Geometry in Indonesia Primary Schools. Doctoral Dissertation. Enschede: University of Twente Freudanthal, H (1991). Revisiting Mathematics Education. China Lectures. Dordrech: Kluwer Academic Publisher, 2002.
[4] J. De Lange, Mathematics Insight and Meaning, OW & OC. Utrecht, 1987.
[5] A. Treffers and F. Groffree, “Rational Analysis of Realistic Mathematics Education: The Weskobas Program,” in Proceedings of the Ninth International Conference for the Psychology of Mathematics Education, 1985, pp. 97–121.
[6] M. Van Den Heuval-Panhuizen, “The didactical use of models in realistic mathematics education: an example from a longitudinal trajectory on percentage,” Educ. Stud. Math., vol. 54, no. 9–35, 2003.
[7] O. Lawanto, “Pembelajaran Berbasis Web Sebagai Metoda Komplemen Kegiatan Pendidikan Dan Pelatihan*,” Unitas, vol. 9, no. 1, pp. 44–58, 2000.
[8] M. C. Sahin, “Instructional design principles for 21st century learning skills,” Procedia - Soc. Behav. Sci., vol. 1, no. 1, pp. 1464–1468, 2009.
[9] Supratman, S. Defit, and Vitriani, “Indeks Kesiapan Perguruan Tinggi dalam Mengimplementasikan Smart Campus,” J. Teknol. Inf. dan Ilmu Komput., vol. 6, no. 3, pp. 267–276, 2019.
[10] S. Zakir and R. Hidayat, “Web-based learning model that can be implemented in learning settings without being limited by time, place and space,” J. Theor. Appl. Inf. Technol., vol. 96, no. 23, pp. 7996–8005, 2018.
[11] B. Sridharan, “Authentic Assessment Methods: A Practical Handbook for Teaching Staff Part-I, Deakin University.,” no. January, 2016.
[12] T. Plomp and N. Nieveen, Educational Design Research Part B: Illustrative Cases, SLO. Netherland Institute for Curriculum Development, 2013.
[13] A. Lewis, “Three coefficients for analysing Reliability and Validity of rating.,” Educ. Psychol. Meas., vol. 45, pp. 131–142, 2015.
[14] J. Van den Akker, Principle and Method of Development Research. In van den Akker, J., Branch, RM, Gustafson, K. Nieveen, N., & Plomp, T. (pt)”. Design Approaches and Tools in Educational and Training. Dordrech: Kluwer Academic Publisher, 1999.
[15] N. Nieveen, Design Approaches and Tools in Education and Training. Springer Science Bussines Media, BV DOI. 10.1007 / 978-94-011-425 5-7, 1999.