Validity of PMRI-Based Geometry Teaching Materials for Elementary School Students

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ABSTRACT

This research aims to develop PMRI-based teaching materials on the elementary school geometry material that meets valid criteria. The research method used in this research is research-type development studies, with research carried out covering three stages: the preliminary stage, the prototyping stage, and the assessment stage. The technique of data collection using walk-through is done by providing teaching materials to experts, who then give comments as well as a mere view of each content, design, and language. Data analysis techniques are the result of a walk-through with experts analysed descriptively as input used to revise the teaching material, validation of the results of expert validation (expert review), and one-to-one results. The results of the development of PMRI-based teaching materials on the valid elementary school geometry materials are derived from the results of expert validation audits in terms of content, construction, and language and one-to-one audits.

Keywords : validity, elementary school geometry, PMRI.

ABSTRAK

Penelitian ini bertujuan untuk mengembangkan bahan ajar berbasis PMRI pada materi geometri sekolah dasar yang memenuhi kriteria valid. Metode penelitian yang digunakan dalam penelitian ini adalah studi pengembangan, dengan penelitian yang dilakukan mencakup tiga tahap: tahap awal, tahap prototipe, dan tahap penilaian. Teknik pengumpulan data menggunakan walk-through dilakukan dengan menyediakan bahan ajar kepada para ahli, yang kemudian memberikan komentar serta pandangan mereka terhadap setiap konten, desain, dan bahasa. Teknik analisis data adalah hasil walk-through dengan para ahli yang dianalisis secara deskriptif sebagai masukan untuk merevisi bahan ajar, validasi hasil validasi ahli (tinjauan ahli), dan hasil one-to-one. Validitas bahan ajar berbasis PMRI pada materi geometri sekolah dasar diperoleh dalam pengembangan ini dari hasil audit validasi ahli dalam hal konten, konstruksi, dan bahasa serta audit one-to-one dinyatakan dalam kategori valid.

Kata kunci : validitas, geometri sekolah dasar, PMRI

INTRODUCTION

Mathematics has an important role in real life because almost every element of real life requires mathematics (Shadiq, 2019), who said that for a person living on earth in the 20th century. It is impossible not to make use of mathematics. Therefore,

students' mastery of mathematics requires the concept of critical thinking to understand the relationship between material and real life. In addition, good forms of communication and socialisation are also needed by students to be able to interact in everyday life, and mathematics is one of the subjects taught at every level of education. By studying mathematics, it prepares students to be able to compete by using a creative, innovative, and imaginative mindset (Utami, 2014). Communication is providing information to other parties to get the same understanding (Wildan, 2013). Therefore, good interaction plays a very important role in developing active and effective learning.

The scope of geometric mathematics is very close to everyday life because it has many benefits. In terms of geometric shapes, examples of its use are calculating the area of an object, measuring the needs for making an object such as a building, and so on. Therefore, geometry requires a fairly high level of critical thinking. Of course, this must be applied early on when students study geometric material. Students learn geometry only by rote and cannot understand the depth of the concept of geometry. Students prefer to learn by rote when they fail to understand the logic of situations about geometric properties (Biber et al., 2013). From the explanation above students need direct visualisation so that they can more easily understand concepts and get direct learning experience. One of the learning designs that supports learning activities is the existence of a learning model that is able to attract students' interest and is easily accepted by students. Make students learning subjects who are given space to explore more of their knowledge and make learning memorable that is close to students' daily lives.

In the context of learning, teaching materials are components that must exist in the learning process because teaching materials are guidelines for understanding a learning material. Without teaching materials, learning will not produce anything. Based on the reality at school, it was found that the teaching materials for learning mathematics were still abstract in nature; the existing teaching materials only displayed formulas and questions. So that these teaching materials have not helped students in the process of thinking and learning mathematics to be meaningless.

The same thing was expressed by (Haji, 2012), who stated that the presentation of material written in mathematics books used today is structured as follows: 1. Definition (understanding the concept), 2. Sample questions, and 3. Practise questions The author explains the definition of a concept in mathematics. Then, the author gives examples of the application of these concepts and ends by giving practise questions. The three stages of writing the book are dominated by the author, while the students (readers) are passive in understanding and working on the questions explained and instructed by the author. In addition, these mathematics books (teaching materials) do not contain non-routine questions and do not challenge students to carry out activities of reflection, experimentation, exploration, inquiry, conjecture, and generalisation. The material presented is monotonous, and the questions are routine.

Various kinds of efforts have been and are still being made by mathematics teachers and researchers to train students' mathematical reasoning abilities in junior high schools, one of which is using the Realistic Mathematics Education (PMR) approach. PMR, or the foreign term, is called Realistic Mathematics Education (RME), or in Indonesia, it is better known as *Pendidikan Matematika Realistik Indonesia* (PMRI). "*Pendidikan Matematika Realistik Indonesia*" is a form of learning that uses the real world and learning activities that emphasise more student activities to seek,

discover, and build their own necessary knowledge so that learning becomes student-centred (Muchlis, 2012). Meanwhile, according to Aisyah et al. (Kusumaningtyas, 2012), in this PMRI approach, mathematics class is not a place to transfer mathematics from teacher to students but rather a place for students to rediscover mathematical ideas and concepts through exploration of real problems. The real world is used as a starting point for learning mathematics. To emphasise that the process is more important than the result, in a realistic mathematics approach, the term mathematization is used, namely the process of mathematizing the real world. Making it easier for students to solve math problems.

One of the ways to influence learning activities is to include teaching materials in these activities. Teaching materials that are designed according to the curriculum and student needs can help students understand mathematics well, so that they are expected to feel happy and motivated to participate in mathematics (Saragih & Hutapea, 2022; Setiawan et al., 2022). In this case, it is necessary to develop mathematics teaching materials in accordance with the demands of the curriculum and the needs of students. Where the teaching materials are close to students' real lives and originate from problems in the environment around students, which can make it easier for students to understand abstract mathematical concepts, so that through this learning, they can develop their mathematical thinking skills well. From the problems above, a solution is needed in order to minimise problems that arise in the learning process, one of which is by developing PMRI-based teaching materials. Teaching materials developed will be an important source and reference for students.

By using PMRI it is hoped that it can improve the quality of learning for prospective teachers and provide opportunities for prospective teachers to better understand the student transition process in learning (Mudaly & Sukhdeo, 2015), because the learning carried out is more student-centred. According to Freudenthal, PMRI is a mathematics learning model that is taught to students and must be connected to reality, closely related to students and linked to social life and human values (Bray & Tangney, 2016). This indirectly shows students that the mathematics they learn can be used to solve students' real-life problems. The teaching materials developed will become important sources and references for students. This is in line with those who have conducted research using Valid PMRI-based teaching materials (Ceria et al., 2022; Riyanti, 2022; Sari, 2017). Based on the background above, the writer is interested in producing valid teaching materials.

METHOD

The research method is design research with type of development studies. The research was conducted in three stages: the preliminary stage, the prototyping stage, and the assessment stage (Plomp, 2013; Van den Akker et al., 2006). The evaluation flow used in prototype development is formative evaluation. The phases carried out included self-evaluation, expert review, one-to-one, small group, and field tests (Tessmer, 1993).

At the preliminary stage, researchers reviewed the research literature including curriculum, materials, and potential students. At the prototyping stage, the researcher followed formative evaluation which included self-evaluation, expert review, one-to-one, small group, and field tests. At the self-evaluation stage, the researcher design the tasks to produce 1st prototype. At the expert review stage, prototype 1 that has been made is validated by experts including content, language, and construction of the tasks.

Valid criteria from validator comments qualitatively. At this stage, a one-to-one process was also carried out on four students to get product revisions. After the revision was carried out at the expert review and one-to-one stages, 1st prototype can be said to be valid and then 2nd prototype is produced.

RESULTS AND DISCUSSION

This development research produced teaching materials in the form of LKM based on the PMRI (*Pendekatan Matematika Realistik Indonesia*) approach for elementary school teacher candidates and PGSD students at PGRI Palembang University. This research uses design research-type development studies. This research includes three stages: the preliminary stage, the prototyping stage, and the assessment stage. This article only discusses the prototyping stage in the expert review and one-to-one to see validity. Each stage of this research is described as follows:

1. The Preliminary Stage

At this stage, reviewing literature reviews, analysing the conditions of critical thinking abilities of prospective teachers (students) and students, and analysing material on campuses and schools The result of the literature review is to get a good literature review regarding supporting theories and problems that occur. The results of the initial conditions are that the ability to think critically is still low, the results of which have been published, which results in 80% of students' critical thinking skills being still low (Mulbasari et al., 2023). According to the results of the material analysis, the material used is elementary geometry material. Then design lecture designs and learning devices.

2. The Prototyping Stage

a. Self Evaluation

The results of the preliminary stage will be carried out or used as a basis for designing teaching materials. Here at the self-evaluation stage, we are re-evaluating the lecture design and learning tools that have been designed, and then these learning tools are discussed with one PGSD lecturer. Based on the results of the discussion with the PGSD lecturer, there are several that need to be revised. The revisions are as follows: (1) There are several editorial questions that must be changed, and (2) From the appropriate context of the material. The results of the discussion with the lecturer are an improvement or revision and produce prototype 1.

b. Expert Review and One To One

At the expert review stage, the validation of experts is carried out. At this stage, the researcher re-evaluates the teaching materials that have been made, both in terms of content, constructs, and language used. After being read and evaluated, it produces the first prototype, which is focused on content, construct, and language. After the first prototype is made, the next stage is an expert review. This stage aims to obtain valid teaching materials. The given prototype 1 was then validated in terms of content, construct, and language. The comments and suggestions from experts as research validators are summarised in Table 1.

Tabel 1. Expert validation results for teaching materials

No	Validator	Comments and Suggestions
1	NK	1. In the instructions for filling in student activities (LKM), there is an editorial that must be corrected. 2. In the image, make the image number and image name. 3. In the editorial questions, there are words that must be changed to achieve the goal. 4. There are several posts that must be changed. 5. The conclusion on page 6 is incorrect. 6. The questions do not match the answers in the scoring rubric.
2	AF	1. In the editorial section of the question on page 6, what is the purpose of this question, as it needs to be clarified? 2. Look again at the concept written; is it appropriate? Her suggestion is that this concept should be discovered by students and not written down by lecturers at LKM. 3. What is meant by a surface pass needs to be discovered and defined by students. 4. The question of determining the surface area of the cube in the question needs to be revised or doesn't need to exist. Adjust to what is known and asked before 5. The formula in the box needs to be considered again; is it appropriate? The same comments should not be written down; students conclude themselves. 6. What is meant by volume needs to be discovered and defined by students. 7. Suggestions for questions: the number of cubes is 81, and there is no need to give a side length of 11 cm. 8. The concept in the box needs to be considered again for its correctness. 9. Where are numbers 1, 2, 3, and 4? As the question sentence needs to be corrected. 10. This question sentence seems to need to be corrected. 11. Same comment as before. 12. Sentences need to be considered again and adjusted.
3	KA	1. Inconsistent in making questions; for example, on page 3 of the teaching material about number 1, it discusses cake boxes, but on page 4 of the teaching material about number 2, the discussion changes to gift boxes. On question number 3, if it is difficult to collect, how will students compare their answers? 2. Be more careful about the use of the words so they don't look ambiguous and can be easily understood by students in elementary schools.
4	YA	1. The teaching module used is very good because it uses the basis of a flat shape in the form of a flat shape. 2. 2. In more detail, in the process of knowing the surface area of a geometric shape, such as a picture of a net of cubes, because children can measure area and volume through nets.

Apart from carrying out an expert review at the same time as carrying out one-to-one interviews with one to four students, at the one-to-one stage, we will get comments from students; the results are below in Table 2.

Tabel 2. Results of one to one teaching materials

One-to-One Student	Comment
Student 1.	1. LKM No. 4, page 4, part C, page 5. The sentence is a bit difficult to understand, but it seems easy if it is changed. For example, on the side of the boundary of the flat shape shown in the picture of the nets above, what is the shape of the flat shape? 2. In LKM No. 4, Part D, Page 5, the sentence is somewhat ambiguous; the question is the number of plane shapes in the picture or the number of types of plane shapes. 3. In LKM No. 5, page 5, the problem is the same as no. 2. 4. The second LKM question number 6 is not neat in its typing and also does not have a page underneath, and this question is the same as number 2. 5. The 3rd LKM no. 2 in the question did not have the number of sides in the gift box, so it could not calculate the required wrapping paper. 6. 3rd LKM No. 5, page 17 The question is the same as No. 2. 7. In 3rd LKM No. 6, Part E, Page 19, there are no numbers indicating the sides of the flat shape. 8. 4th LKM No. 5, page 25 The question is the same as No. 4, Part C.
Student 2.	1. On page 6, part c, I don't understand that the figure doesn't write down the total area of the plane, so I'm confused about how to add it up. 2. On page 10, section no. 3, there is no difference. 3. Page 25, Section 6a I don't know how much it is because I don't understand how the formula and calculation work. 4. On page 12, part b, I don't understand because there is no picture of the rubric where the bottom and sides are above; only the top of the rubric is 6 5. On Page 12, Part C, the questions are difficult, so it's not easy for students to understand. 6. On Page 15, Part 1, the size of the paper that Ani needs should be listed so that students can directly calculate the formula. 7. On Page 23, Part No. 1, I don't understand how to calculate the formula. 8. Page 24 no. 2, 3, and 4: I don't understand how to do it.
Student 3.	1. In the question sentence on the question outlined, it is not yet effective; it is better to write: "Does the shape of the cake box match the shape of the cake?" 2. Use of interrogative sentences according to EYD 3. Presentation plus pictures 4. It is better to add pictures to the presentation of the questions so as to clarify the meaning of the questions. Then, for writing question sentences, it is better to use interrogative sentences: what, where, who, why, when, and how.

One-to-One Student	Comment
Student 4.	1. In this module, there are not enough pictures to help, and some questions about interrogative sentences are quite lacking in understanding; it is necessary to mix again. 2. Using an interrogative sentence that is appropriate for how it starts, is this the intended sentence?

Based on comments and suggestions from experts as validators and four students one to one, the first prototype teaching material was revised again to produce a second prototype.

Based on the process of developing teaching materials that have gone through several stages starting from the preliminary stage to the prototyping stage with a formative evaluation flow that includes self-evaluation, expert review, and one-to-one, a set of teaching materials on geometry has been produced using PMRI, which has been declared qualitatively valid. Teaching materials are developed through the preliminary and prototyping stages.

The teaching materials are first validated by experts consisting of media experts, linguists, and content experts. After being validated by the experts, the teaching materials were revised according to the suggestions of the experts, and at the same time, I was also tested at the one-to-one stage. The results of the expert review and one-to-one production of prototype 2 were checked for validity (Naila & Sadida, 2020). The validation of teaching materials is carried out to determine the quality of teaching materials based on the components of content feasibility, presentation feasibility, language feasibility, and graphic feasibility.

The results of the validation of teaching materials by experts were in the form of statements by material experts, linguists, and content experts that teaching materials were feasible to be tested with several revisions to be made. This expert validation is in line with one-to-one, where the purpose of this one-to-one is to see the readability of teaching materials from the perspective of students consisting of students with low abilities, students with moderate abilities, and students with high abilities. After going through revisions and producing prototype 2, The teaching materials developed are inseparable from the process of preparing teaching materials, which takes into account the three principles of preparing teaching materials, namely the principle of relevance, the principle of consistency, and the principle of adequacy.

Teaching materials that meet the principle of relevance because teaching materials are related to competency standards and basic competencies In the analysis phase of this research, curriculum analysis was carried out, including analysis of competency standards and basic competencies used in cube and block material. The results of the curriculum analysis are used to compile a map of the needs for teaching materials at the design stage. Furthermore, this needs map is used to create the learning flow contained in teaching materials. Through this flow, teaching materials are arranged according to the principle of relevance.

The preparation of this teaching material also uses the principle of consistency because the teaching materials are made consistent with the achievement of the goals that have been achieved. In addition, this teaching material is also prepared based on the principle of adequacy because the prepared teaching materials contain material that is not too little or too much so that the teaching materials to be used are easy for students to understand.

During the use of teaching materials, students practise solving contextual problems in geometry material. The problems presented in teaching materials are related to contexts that are easily encountered by students in everyday life (Elisyah et al., 2023). The use of teaching materials through learning with *Pendekatan Matematika Realistik Indonesia* (PMRI) makes it easier for students to find the mathematical concepts contained in each problem presented in the teaching materials (Gusnia et al., 2023; Simatupang & Siregar, 2023).

CONCLUSION

Based on the results of the research and discussion that have been described above, it can be concluded that the development of teaching materials using Realistic Mathematics Education (PMR) approach on geometry material is stated to be valid, as seen from the results of the revision of expert validation in terms of content, construct, and language and the results of one-to-one revision.

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