Development of Social Arithmetic Teaching Materials Using IT-Based PMRI Approach for SMP Students

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Abstract

This study aimed to develop teaching materials using an IT-based PMRI approach for junior high school students. The type of this research was a research and development model. This study employed the ADDIE development model consisting of five stages: analysis, design, development, implementation, and evaluation. The teaching materials were validated by material experts and media experts before being tested. In addition, this study involved a student response questionnaire investigating the IT-based teaching materials. The validity of teaching materials revealed an average score of 4.40 determined by the results of the teaching material assessment conducted by two expert lecturers, and an average score of 4.80, determined by the results of the teaching material assessment conducted by mathematics teachers at SMP Negeri 56 Palembang. The practicality of teaching materials (student books) had an average score of 4.27 determined by the students' responses to teaching materials. The results of validating material experts, media experts, subject teachers, and student response questionnaires indicated that the teaching materials developed were valid and practical. Overall, this study has shown that the teaching materials developed are very suitable for learning. In addition, the teaching materials developed can improve student learning outcomes on arithmetics materials.

Keywords: Development, Teaching Materials, Social Arithmetic, IT-Based, PMRI

Abstrak

Penelitian ini bertujuan untuk mengembangkan bahan ajar dengan pendekatan PMRI berbasis IT pada siswa SMP. Jenis penelitian yang digunakan adalah *Research and Development*. Pada penelitian ini menggunakan model pengembangan ADDIE dimana dalam tahapannya terdiri dari lima tahapan yaitu *analysis, design, development, implementation, evaluation*. Sebelum diuji-cobakan bahan ajar terlebih dahulu divalidasi oleh ahli materi dan ahli media. Selain itu juga ada angket respon siswa mengenai bahan ajar berbasis IT tersebut. Kevalidan bahan ajar memiliki skor rata-rata sebesar 4,40 ditentukan berdasarkan hasil penilaian bahan ajar yang dilakukan oleh dua dosen ahli dan skor rata-rata sebesar 4,80 yang ditentukan berdasarkan hasil penilaian bahan ajar yang dilakukan oleh guru matematika di SMP Negeri 56 Palembang. Kepraktisan bahan ajar (buku siswa) memiliki skor rata-rata sebesar 4,27 yang ditentukan berdasarkan hasil respon siswa terhadap bahan ajar. Hasil validasi ahli materi, ahli media, guru mata pelajaran dan angket respon siswa menunjukkan bahwa bahan ajar yang dikembangkan adalah valid dan praktis. Secara keseluruhan menunjukkan bahwa bahan ajar yang dikembangkan sangat layak digunakan dalam pembelajaran. Selain itu, bahan ajar yang dikembangkan juga mampu meningkatkan hasil belajar siswa pada materi aritmatika sosial.

Kata kunci: Pengembangan, Bahan Ajar, Aritmatika Sosial, Berbasis IT, PMRI

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INTRODUCTION

The rapid development of science and technological advances in this globalization era can cause global changes in various aspects of life and challenge the nation to prepare future young generations, including students who can obtain, select, and process information to survive in a constantly capricious situation. According to Freudenthal (Lismareni et al., 2019), education must guide students by using conditions and opportunities to rediscover mathematics in their way. This argument is similar to the study by (Widyastuti & Pujiastuti, 2014), stating that the learning process

must be conducted with activities that allow students to perform the learning process and form their ability through actual experience and knowledge connection.

(Raharjo, 2014) argues that teaching materials are an essential part of school education implementation because students cannot relate and apply their learned material to solve problems (Dewi et al., 2019), are not accustomed to constructing their knowledge (Ahyansyah et al., 2020), and must achieve social arithmetic materials.

Nowadays, students' problem-solving skills can be developed using IT that can also be used as one of the teaching materials in delivering complex, complicated, and tedious math topicsfor for students. With the help of various non-print media, teachers can develop attractive and practical teaching materials. Therefore, it is necessary to conduct learning equipped with IT to enable students solve problems and easily understand math. This step agrees with the three didactic functions of technology in mathematics learning; they are (1) technology for doing mathematics, (2) technology for practicing skills, dan (3) technology for developing conceptual understanding (Putrawangsa & Hasanah, 2018).

Using PowerPoint in a learning process makes educators' delivery of social arithmetic materials more effective and efficient. This statement agrees with (Hikmah & Maskar, 2020) , who opine that using PowerPoint media attracts students' interest in learning, and thus, they get satisfactory learning outcomes. A study by (Anomeisa & Ernaningsih, 2020) discovers that teachers and students are interested in mathematics learning media using multi-media PowerPoint because it can motivate students to be more active in group discussions.

The teachers' learning process is still dominated by conventional learning. The textbooks used in the learning process do not present contextual materials; consequently, the students become less active, silent, and rarely engaged with finding mathematical concepts (Riwayati & Ridzky, 2020) . Thus, teachers require comprehensive method of math, especially social arithmetic material.

Learning using the Indonesian realistic mathematics education (PMRI) approach is one of the right methods to teach social arithmetic material. The PMRI approach, as other approaches, can improve students' learning outcomes, creative thinking skills, and mathematical connection (Ankamilah et al., 2013; Rahmadani et al., 2018)). because this approach begins with presenting problems related to students' daily lives. The presentation aims to make students understand that their daily activities are closely related to mathematics. A study by (Nurhidayati, 2017) discovers a PMRI-based mathematics learning module on sequences for class XI high school students, and the module is declared feasible. The student learning outcomes test revealed that the class average is 97.5 and resulted in an effective mathematical sequence module. Research by (Misdalina et al., 2013) concludes that the results of developing integral materials, including the content, language, and context suitability, using the PMRI approach for senior high school students in Palembang are valid.

METHODS

This research was conducted at SMP Negeri 56 Palembang (junior high school) and involved 15 participants. This research employed the ADDIE development model. The research analysis consisted of three steps: (1) analyzing the needs of class VII students to determine their cognitive development in learning mathematics, (2) learning tools used by the students, and (3) learning models applied for the students. By considering Piaget's theory, class VII students were classified in cognitive development aged 12 years old and the formal operational stage that formed concrete operations into more complex operations (Ibda, 2015). Therefore, the learning tools no longer required to be concrete but lead to abstract thinking. This statement agrees with PMRI that the learning model was applied to this research participants. Applying PMRI enables students to imagine concrete objects. The analysis of the mathematics curriculum on social arithmetic material for class seven students of senior high school included core competence and indicators of competence achievement.

The design stage consisted of four steps: (1) making a map of teaching material needs, (2) determining the structure of teaching materials, (3) preparing research instruments, and (4) validating research instruments by expert lecturers. Meanwhile, the development stage consisted of two steps: (1) manufacturing and writing teaching materials and (2) validating teaching materials by material and media experts. The implementation stage consisted of one step testing out the developed teaching materials.

Teaching materials were tried out to class VII students of junior high school. The trial subjects were a mathematics teachers and class VII students of SMP Negeri 56 Palembang. The teacher was a facilitator in the learning process and the students were the main subjects in the trial on the teaching material implementation and technique. This study conducted the trial in the form of learning mathematics using the PMRI approach and teaching materials developed after learning. The students' respond to the developed teaching materials PowerPoint. The evaluation stage consisted of the assessment phase that evaluated the development of teaching materials, including the feasibility components, constructs, and language to determine the quality of the developed teaching materials.

RESULTS AND DISCUSSION

Analysis

The needs of class VII students at SMP Negeri 56 Palembang were analyzed after observing them. The analysis discovered that the students' needs and curriculum in the teaching materials were based on the core competence (KD) and indicators of competence achievement (IPK). KD 3.11 discusses social arithmetic topics, such as sales, purchases, discounts, profits, losses, single interest, percentage, gross, net, and tare. Meanwhile, KD 4.11 discusses problem-solving for social arithmetic topics, such as sales, purchases, discounts, profits, losses, single interest, percentage, gross, net, and

tare. IPK 3.11.1 to 3.11.5 included four objectives: recognizing phenomena or activities, obtaining information, determining relationships of social arithmetic materials, and solving social arithmetic problems (Kemdikbud, 2013). The PMRI approach begins with a phenomenon or activity and is a starting point for instilling concepts in students to emphasize learning activities. This statement agrees (Munir & Sholehah, 2020), who opine that the PMRI is an approach to learning mathematics that emphasizes students' activities and is based on students' real (contextual) cases.

Design

The design stage consisted of three steps. The first was drafting a map of teaching material needs by considering core competencies and indicators of competency achievement. The second was designing the assigned structure of the instructional materials (student book) in three parts: the introduction, the discussion, and the conclusion. The third was producing instruments in which rated subjects assessing the quality of teaching material components were in accordance with the feasibility of the contents, constructs, language, and student response questionnaire and inseparable from the instrument assessing the teaching materials. The students response questionnaires consisted of 28 statements that referred to indicators of the student response questionnaire. One of the results of designing social arithmetic teaching materials is presented in Figure 1.
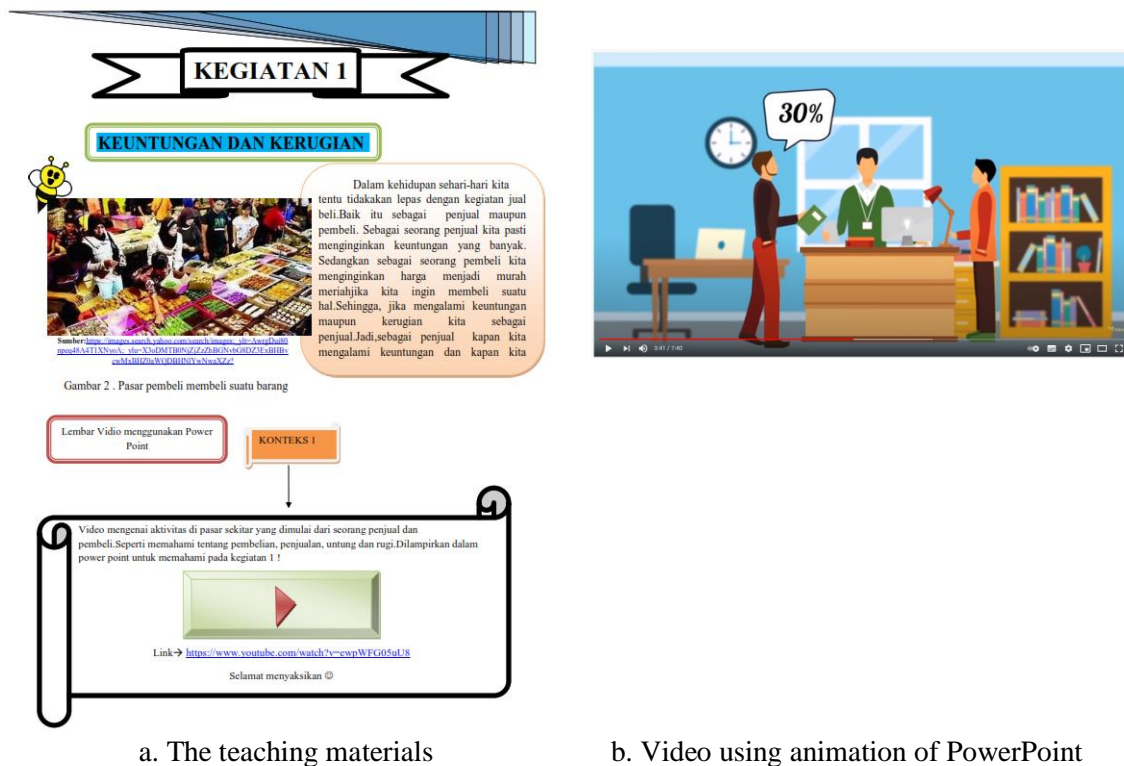
a. The teaching materials   b. Video using animation of PowerPoint

Figure 1. Social arithmetic teaching material design

Development

This stage consisted of two processes: writing teaching materials and validating teaching materials. Writing teaching materials employed the Indonesian realistic mathematics approach formulated by the PMRI team and consisted of three parts: (1) the introduction, (2) discussion describing student activities in student books, presenting PowerPoint, and demonstrating action and competency tests on student books, and (3) the closing. The contents of the student book included nine significant points.

a. The beginning of the chapter: explained social arithmetic and daily life phenomena.

b. Core competencies and indicators of competency achievement are accordance with the 2013 Curriculum Content Standards.

c. The learning materials following the competency standards and core competencies were presented to allow students to know the materials in each chapter to study.

d. A Concept Map presented several social arithmetic materials in the student book,

e. Students watched videos of Powerpoint, performed activities in activity 1, observed the video, and comprehended the contextual problems presented.

f. Students watch videos, the contents of the videos are activities of daily life according to the material. The video contains problems, students observe and try to solve problems in their own way, problems are in accordance with students' daily lives, this makes problem solving easier.

g. The "Discussion" column contains problems to be solved in groups

h. The students were asked to perform actions following the existing instructions to find concepts in daily life and the material in question.

i. At the end of the teaching, the students received a competency test sheet in the student book.

The draft of the development results agreed with the PMRI approach because the students were invited to successfully build their knowledge through activities provided by the teacher in the learning process (Idris & Silalahi, 2016).

Then, the draft of the developed teaching materials was validated. The teaching materials produced at this development stage were validated by material and media expert lecturers (Table 1).

Table 1. Comments from experts review

Validation	Comments	Revision
	The pictures had to match with the listed statement, and thus they were related	Change the pictures
Experts	The concept maps had to be related to each social arithmetic material. Thus, the arrow signed a certain meaning of the material	Revise the concept maps to make them more suitable

Validation	Comments	Revision
	The first material was compulsorily added to the first activity; the video had to contain a clear statement	Adding the first activity using video
	The problem had to contain steps to solve the goal. Therefore, the students could perform this activity following the existing steps or complete it efficiently	Adding questions to guide students in solving problems

Then, based on expert comments from the content, construct and language aspects, it used to revise the teaching materials (Figure 2).

Figure 2. One of the teaching materials after revision

The result of validation were analyze by the researchers. The results of this validation are presented in Table 2.

Table 2. Validation results of teaching materials by material experts and media experts

Aspect	Expert Lecturer		Average Score	Score
	Theory	Media		
Content eligibility	4.75	4.00	4.37	Very good
Construct Feasibility	4.60	3.60	4.10	Good

Aspect	Expert Lecturer		Average Score	Score
Language Eligibility	4.75	4.75	4.75	Very good
Conclusion			4.40	Very good

Table l signifies that material and media experts considered that the teaching materials have excellent categories. Widoyoko (2016) propose several classifications: (1) the average score of 4.2 – 5.0 is excellent, and (2) 3.4 – 4.2 is good/eligible. These classifications support research by (Anomeisa & Ernaningsih, 2020), contending that the mean total score of 3.88 is considered eligible, and the development of mathematics learning media through the interactive PowerPoint VBA multimedia on group data presentation is feasibly implemented in mathematics learning.

Implementation

The student book trial was conducted on class VII students of SMP Negeri 56 Palembang. However, due to the Covid-19, the trial was conducted online six times.

Evaluation

This study involved two mathematics teachers and 15 students in evaluating the teaching material. The evaluation data were then analyzed.

1) Teaching material evaluation by the teachers

Table 3. Evaluation results of teaching materials by mathematics teachers

Aspect	Teacher		Average Score	Score
	1	2		
Content eligibility	5.00	4.25	4.62	Very good
Construct Feasibility	5.00	4.80	4.90	Very good
Language Eligibility	4.75	5.00	4.87	Very good
Conclusion			4.80	Very good

Table 3 shows that the math teachers considered that the results of the teaching material evaluation tested initially met excellent categories.

2) The evaluation of teaching materials by students.

Table 4. Student response result data

No	Indicator	Positive	Negative
1	Suitability of learning material	4.86	1.60
2	Clarity of Information	4.33	1.86
3	Give motivation	4.60	1.37
4	Font usage: type and size	4.44	1.50
5	Use	4.53	1.56
6	Animated clarity of material	4.75	1.65
7	Display Design	4.46	1.40
8	Conformity with Indonesian language rules	4.73	1.13

Students gave significant responses on the suitability of learning materials and the clarity of material animations. This finding indicated that the developed teaching materials were suitable for the learning process and agreed with the PMRI approach that started the learning with phenomena or activities supported by the research results. Munir and Sholehah (2020) define the PMRI approach as an approach to learning mathematics that fosters students' interests and enthusiasm for learning. In addition, PowerPoint helped students understand the material; this finding supports research by (Amadea & Ayuningtyas, 2020), discovering that students prefer that their teacher give PPT before the next lesson and conduct the meeting via virtual meetings using Zoom or other applications during the distance learning.

Figure 3 presents an answer of a student, namely Nurul Apriyani, about achieving the concept at the formal completion stage.

Figure 3. Student activities in achieving the concept

Students completed the use of concepts following the materials. Thus, they could gain new knowledge and the concept by solving problems and utilizing their prior knowledge. This finding agrees with (Hadi, 2017) who asserts that students construct new knowledge from various experiences for themselves. Jupri (2018) argues that the principles of reality, levels, and linkage are dominantly reflected in the teaching materials used in a learning process, while the principles of activity, interactivity, and mentoring are dominantly reflected in the process of learning implementation. Students necessarily try to find or build their principles by considering contextual problems. This statement is in accordance with the research by (Rohim & Asmana, 2018) deploying that during the learning process using PMRI, students perform effective activities, such as mentioning of the material studied, understanding the context, and thinking/choosing the suitable model to solve problems.

The results showed that using social arithmetic teaching materials using the IT-based PMRI approach for class VII students of junior high school in learning math is effective. This finding is almost similar to that of the research by (Mawardi et al., 2019) . Moreover, this study discovered that the linear algebra materials developed using the ADDIE model were categorized as feasible, and the developed teaching materials were excellent. These findings denote that this research improved the results of previous studies on the development of teaching materials using the IT-based PMRI approach.

CONCLUSION

This development research employed the ADDIE development model with five stages: analysis, design, development, implementation, and evaluation. This study revealed that the developed-social arithmetic teaching materials using the IT-based PMRI approach for junior high school students were feasibly implemented in the learning process at SMPN 56 Palembang. The developed teaching materials agreed with the PMRI principles guided reinvention, progressive mathematization, didactical phenomenology, and self-developed models. In addition, the use of PowerPoint as a teaching media helped students understand the materials. Two expert lecturers considered the developed teaching materials 'very valid' and scored it 4.40. Meanwhile, mathematics teachers at SMP Negeri 56 Palembang considered the materials 'very valid' and scored it 4.80. Furthermore, students practiced solving contextual problems on social arithmetic materials in the student book. The problems were related to students' daily contexts. The use of student books in the learning with the PMRI approach facilitated students to find mathematical concepts of each problem. Therefore, the students rated that the teaching materials (student books) were 'very practical' with an average score of 4.27.

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