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Development of Learning Tools Based on Realistic Mathematical Education Approach for Quadrangle Topics for Grade VII Junior High School

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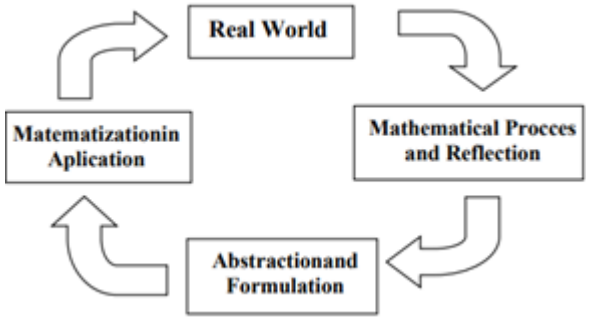
Abstract: ***This article contains the core report on the results of research on the development of learning tools that apply one of the learning approaches to teach the topic of Quadrangles to seventh grade junior high school students. Learning tools based on the Realistic Mathematics Education Approach on the topic of the Quadrangle were developed using a development model adapted from the model of Thiagarajan et al (1974). The model consists of four stages, namely define, design, develop and desseminate which in this study was adapted by eliminating the 4th stage due to limited time and research funds. After the define and design stages, the researcher obtained a set of development results called the initial prototype. At the develop stage, an assessment of the initial prototype device is carried out through a validation process and a field trial process. The validation process is a cyclical activity that can be stopped after valid criteria are achieved. The trial process is an activity to obtain data on the practicality and effectiveness of the developed and cyclical device. This activity is discontinued when the criteria of practicality and effectiveness of war have been met. Through these three stages of development and three validation rounds and two field trials, learning tools were produced that meet the valid, practical and effective criteria for teaching the Quadrangle topic to grade VII junior high school students.***

Keywords: Quadrilateral Topic, Realistic Mathematics Education Approach, Learning Tools, Development Procedure, Valid Criteria, Practical Criteria, Effective Criteria

1. Preliminary

The teacher's contribution is really decisive in helping students achieve the goals and effective learning outcomes that require the teacher's ability to plan and prepare quality learning tools. The teacher's ability to plan and prepare and then apply it to students greatly affects the achievement of learning objectives. According to Kemp (1985: 150) When the new program is being carried out, the teacher or teaching team has the major responsibility for its success. Here Kemp emphasizes that the success of learning activities is the primary responsibility of the teacher. In line with this opinion, Darmadi (2016: 162) argues that teachers are a key source of educational success, it is said so because if teachers are successful in teaching, it is highly likely that their students will be successful as well. That is why the teacher's ability to plan and prepare quality learning tools is a determining factor in achieving effective learning goals and outcomes.In preparing learning tools, the important thing to consider is the selection of the right learning approach or model. Al-Tabany (2017) explains that learning methods are used by educators to create a learning atmosphere and learning process to achieve Basic Competencies that are adapted to the characteristics of students. Various approaches and learning models have been created and even developed by experts in the field of education to help achieve the success of learning activities. These efforts are made to facilitate teachers and students in teaching and learning activities. One of them is the Realistics Mathematical Education (RME) Approach or Realistic Mathematics Education (PMR). This Realistic Mathematics Education theory was proposed by an educator and mathematician from the Netherlands, namely Hans Freudenthal (1905-1990), who specifically designed this approach for learning Mathematics (Webb, et al: 2011). As the name implies, through this approach Mathematics is taught concretely or in real terms by using real objects. These real objects are used to help explain Mathematics which is usually considered difficult because it is presented through abstract symbols. According to Azizah et al (2021) PMR makes students feel abstract mathematics into something that is reality and learning becomes meaningful (meaningful learning). They said that the PMR approach brought students' thoughts related to mathematical abstraction into something real or contextual so that mathematics learning became meaningful. This theory is in line with the opinion of experts from decade to decade that in principle Mathematics is closely related to human activities. Beginning with the originator of the RME approach Frudenthal (1973) in Webb et. al. (2011), followed by Fielker (1981); De Corte et al. (1996); Morgan (2001); Morgan (2016), Moumoun, L. (2022); etc., they interpret that Mathematics is a human activity or mathematics is a human activity. De Lange in Azizah et al (2021) is one of the supporters of this RME approach as shown in Figure 1.



Gambar 1: Matematisasi Konseptual menurut De Lange (1987)

The concept of learning mathematics according to De Lange (1987) as seen in the figure above is believed to be suitable for use in learning geometry. First, because students' thinking will be brought to the real world (real world) this can be related to geometry. Second, contextual thinking is brought to mathematical thinking (mathematical process) and reflection activities in order to connect mathematical material with contextual understanding or real conditions that have been instilled in students' thinking. Third, students are directed to understand abstract symbols and formulas (abstraction and formulas). Fourth, apply abstract symbols and formulas in mathematical calculations (Matematization in application). This fourth stage is not the end of this learning concept because after students are able to apply it mathematically they are directed to use this mathematical concept in real life or real objects.

As a branch of Mathematics, Geometry is abstract (Koedinger, & Anderson, 1990; Hanafi, 2018; and Fonna & Mursalin, 2018). This geometric abstraction is one of the causes of students' difficulties in understanding Geometry concepts and materials. This challenges teachers to really be able to instill concepts that can open students' minds to connect the abstractions of Geometry with contextual problems. As the main principle of the RME approach in the explanation above. This has triggered researchers to conduct research in the field of Geometry using the RME approach such as Budiyono et al., 2019, Maulidiyah, 2018, and Asma, et al. 2019. Triangles and quadrilaterals are included in the geometry material taught in grade 7. As the first grade at the junior high school level, it is very important to be given a strong concept planting because later in grades 8 and 9 they will learn advanced material from triangles and quadrilaterals.

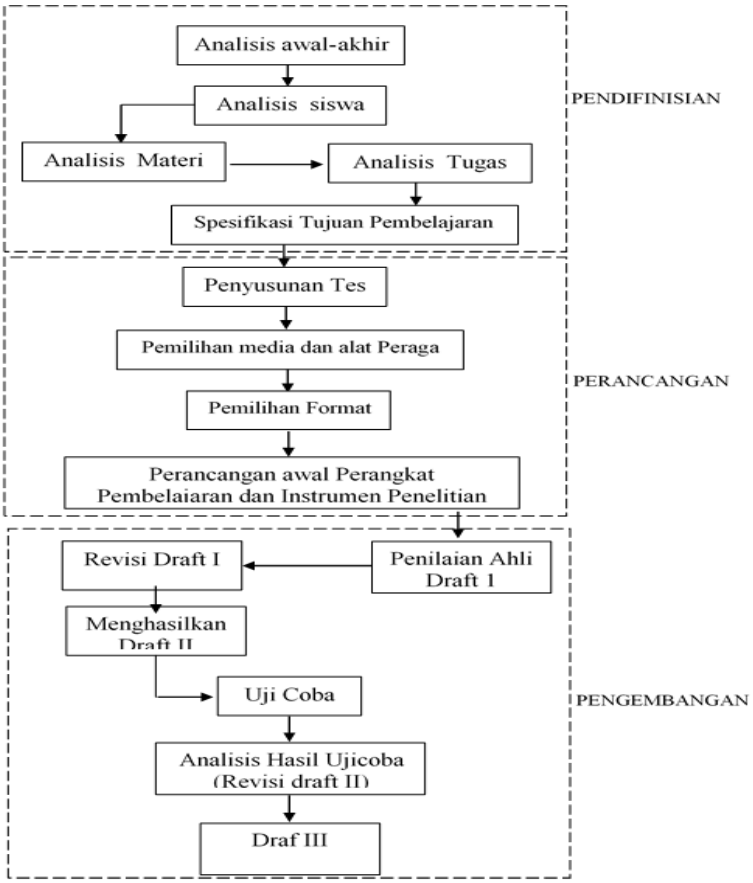
The main principles of PMR are translated into PMR characteristics. Furthermore, the characteristics of PMR are translated into operational steps in learning. Based on the understanding, main principles and characteristics of PMR as described, core steps (activities) in realistic mathematics learning can be designed, namely: (1) Understanding contextual problems: The teacher gives contextual problems and asks students to understand the problem. If there are certain parts that are less or not understood by some students, then students who understand that part are asked to explain them to their friends who do not understand. If students who do not understand earlier feel dissatisfied, the teacher explains further by giving limited instructions or suggestions (as needed) about the situation and condition of the problem.Instructions in this case are in the form of questions that direct students to understand the problem (question), such as: "What is known from the question?", "What is being asked?", "What is the strategy or method or procedure that will be used to solve the problem? that?". At this stage, the characteristics of PMR that emerge are using contextual and interaction problems; (2) Solving contextual problems: Students are individually asked to solve contextual problems in the Student Book or LKPD in their own way. Different ways of solving and answering problems are preferred. The teacher motivates students to solve the problem by providing guiding questions to direct students to get the solution to the problem. For example: “How did you know that?”, “How did you do that?”, “Why do you think like that?”, and so on. At this stage students are guided to rediscover mathematical concepts or principles through contextual problems given. In addition, at this stage students are also directed to form and use their own models to make it easier to solve problems (questions). The teacher is expected not to need to tell the solution to the problem or problem, before students get their own solution.In this step, the characteristics of PMR that emerge are using models and interactions; (3) Compare and discuss answers: Students are asked to compare and discuss their answers in small groups. After that, the results of the discussion were compared to a class discussion led by the teacher. This stage can be used to train students' courage to express their opinions, even though they are different from other friends or even with their teachers. The characteristics of PMR that appear at this stage are the use of ideas or student contributions and interactions between students and students, between teachers and students and between students and learning resources; (4) Concluding: Based on the results of group discussions and class discussions conducted, the teacher directs students to draw conclusions about concepts or definitions, theorems, principles or mathematical procedures related to contextual problems that have just been solved. The characteristics of PMR that emerge in this step are the use of ideas or student contributions and interactions.

Learning tools are a collection of learning resources that allow teachers and students to carry out learning activities. The learning resources referred to here can be in the form of a Learning Implementation Plan (in accordance with Permendikbud number 22 of 2016), student books, teacher books, Student Worksheets (see in Majid, 2013, Trianto, 2007, Prastowo, 2011) in accordance with the syntax PMR learning approaches and Learning Outcomes Tests (see Hudoyo, 1988 and Subino, 1987). The teacher and student books in this study used a book issued by the 2017 revision of the Ministry of Education and Culture.

Quadrilateral Material for SMP Class VII. Solving contextual problems related to the area and perimeter of a quadrilateral is one of the competencies that should be achieved by class VII students. In fact, all around us there are various objects that are rectangular in shape. Among them are house doors, windows, kites, house ceilings, tables and so on. The shape of the rectangle and it varies from irregular and regular.For more details, the quadrilateral material is discussed in the order (1) Types of Quadrilaterals, (2) Properties of Quadrilaterals, (3) Areas and Perimeters of Quadrilaterals.

2. Research Procedure

The development model used to develop learning tools in this study refers to the 4-D model proposed by Thiagarajan, Semmel and Semmel which consists of four stages, starting from the definition stage, design, development and dissemination stage. (disseminate). In accordance with the problem, the learning tools that will be developed are based on learning with the PMR approach to the Quadrilateral material. Given the limited time and research costs, the research on the development of learning devices with the 4-D model is limited only to the develop stage.



Graph 2: Description of each stage of Learning Device Development based on a modified 4-D model

At the end of the define and design stage, the researcher gets a developed device called the initial prototype. Through the stages of development, validation and testing were carried out to obtain data to measure the achievement of valid, practical and effective criteria (Nieveen, 1999). In the implementation of field trials at SMP Negeri 3 Kakas where learning is the partner teacher (teacher in the field of study). The chart of the results of the modification of the learning device development model in this study is shown in Figure 2.

The data from the validators' analysis of the learning tools were analyzed descriptively. Furthermore, the values obtained are categorized with the following validation level

Table 1: Validity of the Learning Implementation Plan (RPP)

NO	Uraian	Nilai Yang Diberikan Validator		
		1	2	3
1	*2*	*3*	*4*	*5*
I	Indikator			
	1. Kemampuan yang terkandung dalam indikator	3	3	4
	2. Ketepatan penjabaran Kompetensi dasar kedalam IPK	4	4	4
	3. Jumlah IPK dibandingkan dengan waktu yang disediakan	4	4	4
	4. Kejelasan rumusan IPK	4	4	4
	5. Operasional rumusan IPK	4	4	4
	6. Kesesuaian IPK dengan tingkat perkembangan siswa	3	3	4
II	MATERI YANG DISAJIKAN			
	1. Sistematika penulisan IPK	3	3	4
	2. Keseuaian konsep dengan IPK	4	4	4
	3. Kebenaran konsep	3	4	3

NO	Uraian	Nilai Yang Diberikan Validator		
		1	2	3
1	*2*	*3*	*4*	*5*
	4. Urutan konsep	4	3	3
	5. Tugas mendukung konsep	4	4	4
	6. Keseuaian tingkat materi dengan perkembangan siswa	4	4	3
III	BAHASA			
	1. Penggunaan bahasa ditinjau dari Bahasa Indonesia	4	3	4
	2. Sifat komunikatif bahasa yang digunakan	3	4	4
IV	WAKTU			
	Kesesuaian alokasi waktu yang digunakan	4	3	4
V	METODE SAJIAN			
	1. Memberikan siswa masalah yang bersesuaian dengan materi untuk dipecahkan	4	4	4
	2. Memberi kesempatan berpikir dan bertanya kepada siswa	3	4	4
	3. Membimbing dan mengarahkan siswa memecahkan masalah	3	4	4
	4. Membimbing siswa untuk membandingkan atau mendiskusikan masalah	4	4	4
	5. Mengarahkan siswa untuk menarik kesimpulan	3	4	4
VI	MANFAAT/KEGUNAAN			
	1. Dapat digunakan sebagai pedoman bagi guru dalam pembelajaran	4	4	3
	2. Dapat merubah kebiasaan pembelajaran yang terpusat kepada siswa	4	4	4
Jumlah Nilai		73	74	76
Nilai Rata – Rata		3,65	3,7	3,8

3. Results and Discussion

After the activities in the define and design stages, the draft I learning tools were obtained, namely RPP, LKS and THB which were the initial prototype devicesThese draft I documents were then assessed according to Nieveen's (1999) criteria which include Valid, Practical and Effective aspects. This assessment process is cyclical, meaning that if the object of the assessment document does not meet these criteria, it will be revised according to the correction and asked to be validated again, or a trial is carried out again to assess practical and effective aspects.

Table 2: LKPD Validation Results

No	Aspek Yang Dinilai	Nilai Yang Diberikan Oleh Tiap Validator		
		1	2	3
1	*2*	*3*	*4*	*5*
1.	**Format LKPD**			
	a. Kejelasan pembagian materi	4	4	4
	b. Penomoran	4	4	4
	c. Kemenarikan	4	4	4
	d. Keseimbangan antara teks dan ilustrasi	4	4	4
	e. Jenis dan ukuran huruf	4	4	4
	f. Pengaturan ruang (tata letak)	4	4	4
	g. Kesesuaian ukuran fisik buku dengan siswa SMP	4	4	4
2.	**Isi LKPD:**			
	a. Kesesuaian Kurikulum 2013	4	4	4
	b. Kesesuaian dengan Pedoman Pembelajaran, Buku Guru dan siswa serta rencana pembelajaran	4	3	4
	c. Kebenaran konsep/kebenaran materi	3	3	4
	d. Kesesuaian urutan materi	4	3	4
	e. Penggunaan kata dan istilah serta simbol	4	3	4
	f. Mengembangkanketerampilan proses/pemecahan masalah serta berfikir tingkat tinggi	3	3	4
	g. Sesuai dengan karakteristik dan prinsip pendekatan saintifik	4	3	4
3.	**Bahasa dan Tulisan**			
	a. Menggunakan bahasa yang komunikatif dan struktur kalimat yang sederhana, sesuai dengan taraf berpikir dan kemampuan membaca serta taraf usia siswa	4	4	4
	b. Menggunakan bahasa indonesia yang baik dan benar	4	4	4
	c. Menggunakan tulisan, ejaan dan tanda baca sesuai dengan EYD	4	4	4
	d. Menggunakan istilah-istilah secara tepat dan mudah dipahami siswa	4	3	4
	e. Menggunakan arahan dan petunjuk yang jelas, sehingga tidak menimbulkan penafsiran ganda.	3	3	4
4.	**Ilustrasi, Tata Letak Tabel dan Diagram/Gambar**			
	a. LKPD disertai dengan ilustrasi, Tabel, Diagram atau gambar yang berkaitan langsung dengan materi pelajaran atau kosep yang dibahas.	3	3	3
	b. Ilustrasi, tabel, diagram atau gambar dibuat dengan tata letak secara efektif	3	3	3
	c. Ilustrasi, tabel, diagram atau gambar dapat digunakan untuk memperjelas konsep/materi	4	3	3
	d. Ilustrasi, tabel, diagram atau gambar menarik,jelas terbaca dan mudah dipahami	3	3	3
5.	**Manfaat/ Kegunaan LKPD**			
	a. Dapat digunakan sebagai pedoman bagi guru maupun siswa dalam pembelajaran	4	3	4

b. Dapat merubah kebiasaan pembelajaran yang terpusat kepada guru menjadi terpusat kepada siswa	4	3	4
Jumlah Nilai	93	86	96
Nilai Rata-Rata	3,72	3,44	3,84

In the first assessment of the validity aspect, it turned out that the results were not valid and there were notes given by the validator. After revision and reassessment, valid results were obtained, as presented in the following tables. The resulting document is hereinafter referred to as draft II (see Figure-1). From table 1 above, it can be seen that the three validators gave an assessment of 3 and above, meaning that the components in the lesson plan received a good rating, so the three validators concluded that the lesson plan could be used with slight revisions. Thus the RPP was revised only based on the validator's suggestions.

Furthermore, Table-2 contains the average assessment of the validators on the LKPD which includes aspects of the format, language and content of the LKPD. In making revisions, the researcher refers to the results of the discussion by following the suggestions and instructions of the validator.

Based on the table above, it can be seen that the three validators gave an assessment of 3 and above, meaning that the components in the LKPD received good and very good ratings. The three validators concluded that the LKPD could be used with a few revisions. Thus, the LKPD was revised only based on the validator's suggestion. Results Validation Test learning outcomes. The assessment carried out by the validator includes indicators: content validity, language and question writing, and recommendations or conclusions. In making revisions, the researcher refers to the results of the discussion by following the suggestions and instructions of the validator. The results of expert validation of THB are presented in table 3 below:

Table 3: Validity of Learning Outcomes Test (THB)

Butir Soal	Validitas isi				Bahasa dan Penulisan			Kesimpulan			
	V	CV	KV	TV	SDP	DP	KDP	TR	RK	RB	PK
1	3				3			3			
2	2	1			2	1		2	1		
3	3				3			3			
4	3				3			3			
5	3				3			3			
6	2	1			1	2		2	1		
7	3				3			3			
8	3				3			3			

Keterangan :
V : Valid
CV : Cukup valid
KV : Kurang valid
TV : Tidak valid
TR : dapat digunakan tanpa revisi
RB :dapat digunakan tetapi dengan revisi besar
PK : belum bias digunakan, masih perlu konsultasi

SDP : Sangat dapat dipahami
DP : Dapat dipahami
KDP : Kurang dapat dipahami
TDP : Tidak dapat dipahami
RK : dapat digunakan dengan revisi kecil

The results of the expert assessments contained in the data in Table 3 show that the Learning Outcomes Test device or instrument is valid and quite valid for the content validity aspect, classified as very understandable and understandable for the language and writing aspects so that the validators conclude that all test items are acceptable. without revision. Furthermore, the draft B document was tested to obtain practicality and effectiveness data (see Figure-1). In Trial I almost all of the indicators have not reached the set criteria, but after Trial II, data on Practicality and Effectiveness have been obtained, where each set indicator has been achieved, so that in Test II, researchers have succeeded in obtaining practical and effective tools, as shown in the tables below.

Table 4: Practical Observation Results: Teacher's Ability to Manage Learning with Devices Developed in Trial II.

No	Aspek yang diamati	Pertemuan Ke-			
		I	**II**	**III**	**IV**
I	**Pendahuluan**				
	1. Memotivasi/mengkomunikasikan tujuan pembelajaran	4	4	4	4
	2. Menghubungkan pelajaran hari ini dengan pelajaran sebelumnya (terdahulu)	4	3	4	3
II	**Kegiatan Inti**				
	1. Memberikan masalah yang berkaitan dengan materi	4	4	4	4
	2. Mengarahkan siswa untuk menemukan jawaban dan cara untuk menjawab soal dengan memberi petunjuk / bantuan seperlunya	4	4	4	4
	3. Mengamati cara siswa menyelesaikan masalah secara bergiliran	4	4	4	4
	4. Mendorong siswa untuk membandingkan jawabannya dengan jawaban temannya dalam kelompok	4	4	4	4
	5. Mendorong siswa untuk mengemukakan pemikirannya atau menanggapi pemikiran yang dikemukakan oleh teman-temannya pada diskusi kelas	3	3	4	3

	6. Menghargai berbagai pendapat	3	4	3	3
	7. Mengendalikan negosiasi	4	3	4	3
	8. Mengarahkan siswa menarik kesimpulan suatu prosedur/konsep	4	4	4	4
	9. Memberi kesempatan kepada siswa untuk bertanya dan menjawab pertanyaan siswa.	3	4	4	3
III	**Penutup**				
	1. Menegaskan kembali kesimpulan materi	4	4	4	4
	2. Memberikan tugas rumah	3	4	3	4
IV	**Pengelolaan Waktu**	4	4	4	3
V	**Suasana Kelas**				
	1. Antusias siswa	4	3	4	3
	2. Antusias Guru	4	4	4	4
	Rata-Rata	**3,73**	**3,73**	**3,87**	**3,53**

Based on table 4, the criteria for the teacher's ability to manage learning, the teacher's ability to manage learning at the second meeting reached the "good" category, which is located in the interval 3.50 TKG < 4.00.

Table 5: Student Activity Data during Learning Activities in Trial II

No	Aktivitas Siswa	Persentase %				Rata-rata
		pert. 1	pert. 2	pert. 3	pert. 4	
1	Mendengarkan/memperhatikan penjelasan guru atau teman dengan aktif	12.50	12.50	12.50	12.50	12.5
2	Membaca (buku paket/LKPD)	15.00	16.67	12.50	16.67	15.21
3	Bekerja dengan menggunakan LKPD	43.75	37.50	43.75	37.50	40.63
4	Berdiskusi / bertanya antara siswa dan guru	10.00	12.50	12.50	12.50	11.88
5	Berdiskusi / bertanya antara sesama siswa	17.50	19.17	18.75	19.17	18.65
6	Prilaku yang tidak relevan dengan KBM	1.25	1.67	0.00	1.67	1.15

So this learning device is not revised based on the results of observations of the ability to manage learning. From Table 5 above, it can be seen that the dominant activity carried out by students in learning is working using LKPD 40.63%, while the 4th aspect of discussing / asking students with the teacher is only 11.88%. Based on the criteria for the ideal time set in chapter III, the use of student activity time in the learning process has been going well as desired.

Table 6: Percentage of Student Responses to Learning Components

Uraian	Senang		Baru	
	Frequency	%	Frequency	%
1	*2*	*3*	*4*	*5*
1. Bagaimana Pendapatmu tentang:				
a. Materi pelajaran	14	93	13	86
b. LKPD (aktivitas)	15	100	15	100
c. Cara Belajar	14	93	12	80
d. Cara guru mengajar	15	100	14	93
Rata-rata	14.5	96	13.5	90
Uraian	**Berminat**		**Ya**	
2. Apakah kamu berminat untuk mengikuti kegiatan belajar seperti yang telah kamu ikuti saat ini?	15	100	-	-
3.a. Apakah kamu dapat memahami bahasa yang digunakan dalam LKPD?	-	-	13	86
3.b. Apakah kamu tertarik pada penampilan(tulisan, besar huruf, gambar, warna) yang ada pada LKPD?	-	-	14	93

Based on the results of the student response questionnaire in Table 16 above and the criteria set out in chapter III that the student response is said to be good if the percentage of each aspect is greater than or equal to 75%, so it can be concluded: (1) Student responses about the teaching components are all good, (2) The student's response to following the next lesson as has been followed, the readability/understanding of the LKPD, and the interest of the LKPD used are good. Based on the results of the student response questionnaire in the table above and the criteria set out in chapter III that the student's response to all aspects is above 80% which is included in the criteria set out in chapter III. This means that every aspect is responded positively by students. Thus, the learning device does not undergo revision based on student responses.

4. Conclusions and Suggestions

Based on the results described in the previous chapter, it can be concluded that Mathematics learning tools with the PMR approach on Quadrangle Material were developed using a modified 4-D development model through 3 stages, namely the stages of defining, designing, and developing that meet the criteria. valid, practical and effective, the following results were obtained: (1) At the design stage, the learning tools were produced in the form of lesson plans for 4 meetings, 4 LKPD, and learning outcomes tests. While the validation and observation instruments used instruments that had been developed by previous researchers with slight modifications; (2) At the development stage through the expert validation stage and field trials: (a) Expert validation results show the RPP and LKPD are quite good and can be used with minor revisions, while the learning outcomes test has included all the indicators of the assessment criteria, (b)

Field trial results showed that several aspects of learning were observed to be ineffective, and improvements were made by revising RPP1, LKPD1, the revised results were adjusted to RPP2, LKPD2, and so on, until the trial phase 3. While the learning outcomes test is seen from the validity index, and the reliability obtained is quite feasible to use without revision. ; (3) Development of learning tools for rectangular subjects with the PMR approach, resulting in learning tools consisting of Learning Implementation Plans (RPP), Student Worksheets (LKPD), and Learning Outcomes Tests. For teachers and advanced researchers, it can be suggested that: (1) The results of this study are a description of the sample class consisting of only one class. Therefore, this learning tool needs to be tested again in parallel classes so that better learning tools will be obtained; (2) This research is only up to the development stage. To find out how effective this learning tool is and how different it is from the learning that has been carried out in the trial class, it is necessary to proceed to the next stage, namely the disseminate stage.

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