



## Developing MITRA Learning Model of Problem Solving-Based to Solve Mathematical Problems in Elementary School

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### Abstract

The research aimed to develop the steps of MITRA learning model of problem solving-based to solve mathematical problems in elementary school, to know the product's validity level of MITRA learning model of problem solving-based according to expert's validation, and to assure the effective level of MITRA learning model of problem solving-based. The research type was Research and Development (R&D), which is a procedure to develop a new product or improve the existed product. The research procedure was divided into three stages, they are: preliminary study, developing model stage, and testing product. The research results found: (1) the steps of MITRA learning model of problem solving-based are: problems identification, implementation of MITRA, and evaluation of MITRA; (2) product's validity level of MITRA learning model of problem solving-based according to expert's validation was 3,75 (75%) on high category, and the media expert was 214 (76,5%) on high category; and (3) product's effectiveness was on very effective category for students of grade 4 elementary school reaching 97%, and the result was significantly higher than pretest (60%).

**Keywords:** MITRA learning model, problem solving, interactive multimedia, Android, result of mathematics learning

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### Introduction

Mathematics is a subject containing full of life needs, such as a means of education. Mathematics as a means of education plays a role in human activities obtained from the thinking process, and it was not obtain from the experimental results. According to Johnson & Rising, quoted by Ismunamto (2011, pp. 2-3), mathematics is the mindset, idea, an art, language, and knowledge. In short, mathematics plays a role in the aspects of cognition.

Mathematics plays an important role in the development of Information and Communication Technology (ICT). The use of ICT in the learning process may advance the thinking skill of learners (Arif, 2016, p. 49). Learners may become more active in learning to take a greater responsibility such as looking for information, processing the information, making conclusions, practicing, and then implementation.

The use of ICT does not intend for learners to have technical knowledge about ICT,

but learners may use ICT as a medium of learning to support the learning process. The supported media to learning process may refer to all types of ICT, such as calculators, computers, smartphones, Internet access, and other sources of ICT. In fact, the supported media are widely circulated and used as a means of learning, moreover, the use of classical media such paper and stationery is now beginning to be abandoned, but not lost.

In the implementation, the use of ICT in Elementary School (SD) is still a problem, and it impact to not optimal of using ICT in learning mathematics. The students problems of learning mathematics in elementary school are generally students' able to memorize the concept by teachers teaching in the classroom, but learners do not maximize the use of the concept if finding obstacles or problems in everyday life; and, learners have less ability to understand the problem, and less ability to formulate. The

problems generally are in the unmaximal students' ability of counting.

Counting is the most basic learning in mathematics. Fractional material is one of counting learning which often becomes problem for learners in solving the task. The use of memorizing learning method in the fraction material tends to be dominantly used by learners rather than the basic concept of the fraction.

The results of preliminary study, it may conclude that the teacher has maximized all the method to deliver the information to learners in learning mathematics. However, by the perspective of learners, ICT-based collaborative learning activities have not been interactive. Responding to the reality, it is necessary to give contribution in helping the students utilize ICT as a facility of learning that may help to arise the higher-order thinking skills (HOTS) in learning mathematics, especially on fractional materials.

According to Abdillah & Sudrajat (2016, p. 43), teaching materials or learning materials that are designed will be more interesting by multimedia touching. Recently, multimedia grows into perfect with graphical support (such as colors, fields, shapes, composition, and interactivity or links) and programming languages. Thses support may displayed in forms of information delivery of text, images/ graphics, audio, video, and animation (moving images), and the learning are more interactive for learners. The excess of the use of teaching materials or learning materials in the form of interactive multimedia are; such as may attract the students' interest compared to classical media such as using paper and stationery (Yunus, Astuti, & Khairina, 2015, p. 59).

Interactive multimedia contains work steps instruction and processes that can be displayed on the smartphone screen, in order the students are easier and faster to learn due to it is in visual display (Sudrajat & Muslim, 2012, p. 4). Although, in some schools, the use of smartphones is still the pro and contra opinions, then there are schools that forbid the students to bring and/or use smartphones in the school. In contrast, there are also schools that allow students to bring and/or use smartphones for learning in the school. The reason, by using smartphones in the learning through an interesting visualization, it may train the students as users to more active.

According to Hidayat & Sudarma (2011), Android is an operating system for mobile devices that are open source and developed

based on the kernel of Linux. Android originally developed by Android Inc., but today, its development are led by Google starting in 2005 (2011, p.192). According to Aziz (2012, p. 5), Android is an operating system for touch-screen smartphones such as iOS iPhone and OS Blackberry. According to Kusuma, Android is known as the green robot system (2011, p.9). Android is a ready-made system for daily use according to user activity easily without the need to settings (Kusuma, 2011, p. 12). In sum, Android is the operating system on smartphones and ready for use by users.

By the problems occur of mathematics learning in elementary school; it needs to develop the products Interactive Multimedia Android (MITRA) to improve the quality of learning by offer the use of Smartphones in learning mathematics. Students are allowed to use Smartphone aiming to direct its use to the activities of learners who live, full of value, and have a positive goal of creating good habituation to learners through using ICT. However, it also needs to monitor, in order the learning of mathematics able to run according to intended objective in the curriculum.

The interaction in the MITRA development is similar to the students' interaction with textbooks and / or a tutor using instructional media, then it able to provide an insight into different inputs and may have an impact on problem solving of mathematics.

The privileges of MITRA, there are learning model and makes MITRA more strategic and innovative when used in the learning of mathematics, which is the problem solving learning model. Problem solving learning model is a learning procedure that makes students are motivated to be active in the learning, and it may solve the problems (Johan, 2012, p. 140). The use of MITRA learning model of problem solving-based in learning mathematics may answer the students' needs due to the students will be actively involved by using Smartphone, and the result, the fractional problem is able to solve.

The objectives of the research were: (1) to develop the steps of MITRA learning model of problem solving-based to solve mathematical problems in elementary school; (2) to know the product's validity level of MITRA learning model of problem solving-based according to expert's validation; (3) and, to assure the effectiveness level of MITRA learning model of problem solving-based.

## Method

The research is a Research and Development (R & D), which is a procedure to develop a new product or improve the existed product. The research was conducted in a month; from September until November 2017 at SD Negeri Tegalrejo 01 Salatiga. Procedure of research consisted of three stages: preliminary study, model development stage, and testing product. In the preliminary study, there are literature studies on the phenomenon of each research variables, they are: learning model in general, problem solving learning model, interactive multimedia, Android, and 4D development model. Then, it continues to the survey at school to find out the learning model, and then, drafting the model. In the development stage, it conducted model validation and limited field test of the developed draft model based on the field needs.

According to Sukmadinata (2013), R & D is a procedure to develop a new product or improve the existed products, then produce responsible products (2016, p.164). The product in this study was MITRA learning model of problem solving-based to solve mathematical problems in Elementary School.

The R & D research procedure used systematic steps and may efficiently implemented if there is a development model. The development model in the R & D is 4D or Four D Models. According to Bitto (2009, p. 56), 4D models have stages: define, design, develop, and disseminate. Thus, the development research procedure according to Sukmadinata (2013) using the 4D development model is converted in Figure 1.

First, the preliminary study stage is the first procedure in the development of the research. In this stage, it conducted to describe the development of MITRA learning model of problem solving-based to solve mathematical problems in Elementary School through literature study, field survey, and preparation of initial product draft. Literature studies conducted in the research through journals, selected books, magazines, and other relevant sources. The literature study is conducted in order to understand the phenomenon of each research variables, which are: learning models, problem solving of learning model, interactive multimedia, and Android. Not only sources related to R & D model, but also there are models of R & D, especially the 4D model.

The results of the preliminary study conducted by the authors to 6 teachers in SD

Negeri Tegalrejo 01 Salatiga, found that teachers: master the material to deliver in teaching to students, motivate the students to focus on learning math, maximize the use of textbooks and include other related sources learning materials as a source of information, provide structured tasks to students in and outside the classroom, give responses in the form of awards and / or sanctions to students, optimize the use of instructional media, and use ICT media as a means of delivering information to students. The results of the preliminary study, then there should be the steps of MITRA learning model of problem solving-based.

Preparation of initial product draft as a response to preliminary study results, then, determines the Basic Competence (KD), prepares the fourth grade mathematics learning syllabus, develops 4th grade Learning Plan (RPP) that contains MITRA learning model of problem solving-based to solve mathematical problems in Elementary School, and design of MITRA storyboard.

Second, the product development stage is the second procedure in research development, but it still include in the preliminary study. In this stage, it conducted the design of the development of MITRA learning media of problem solving-based to solve the mathematics tasks of SD. And then, it conducted expert validation and limited trial test. After that, it conducted validation by material experts and media experts toward MITRA learning model of problem solving-based. By the validation, it conducted a product revision to the MITRA learning model of problem solving-based. By the revision, the product will look good improvement according to the advice of experts of material and media.

Product model of MITRA learning media of problem solving-based is ready to have limited trial test to students of 4th grade SD Negeri Tegalrejo 01 Salatiga. Result of limited trial test is; there are revisions, and need to have revisions. The result of second revision of product model of MITRA learning media of problem solving-based; finally the product able to have widely trial test to students of SD Negeri Tegalrejo 01 Salatiga which is more number of students involving in the product' test compared to limited trial test. After limited trial test, the product development process of MITRA learning media of problem solving-based is declared as complete.

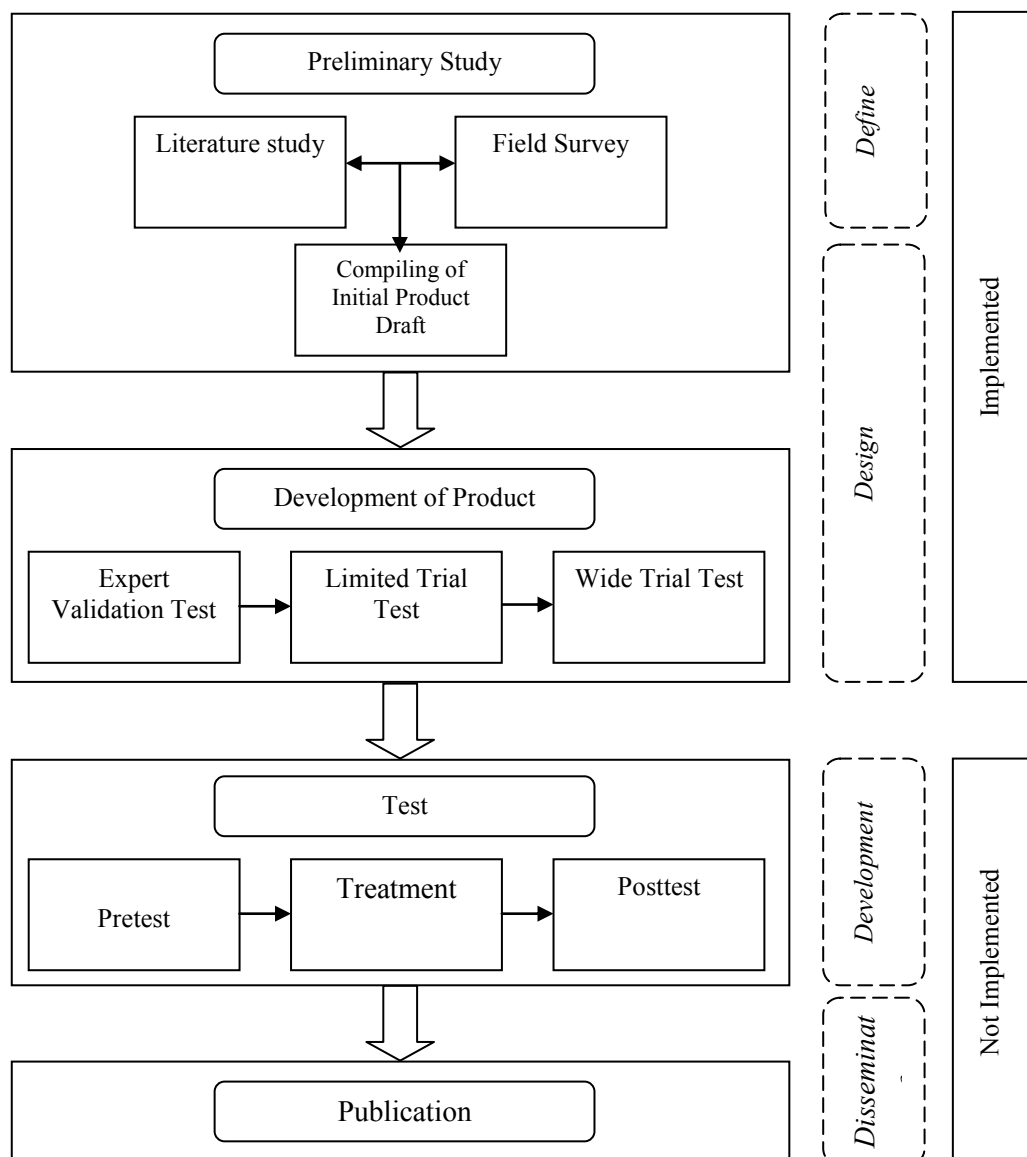


Figure 1. Research Procedure of MITRA learning model of problem solving-based to solve mathematical problems in Elementary School

### Results and Discussion

The preliminary study found out a gap between ideal conditions that were supposed to exist in realities in the subject of mathematics in Elementary School. Teachers at SD Negeri Tegalrejo 01 Salatiga have maximized all the way of information delivery to students in learning mathematics. However, from the students' perspective, ICT-based collaborative learning activities have not been interactive.

Based on the observation result from 6 teachers in SD Negeri Tegalrejo 01 Salatiga obtained data: (1) 83.33% teachers prepare relevant lesson plans in writing before the learning, (2) 100% teachers master the material, (3) 100% teachers motivate their students to focus in learning mathematics, (4) 100%

teachers maximize the use of textbooks and other resources related to learning materials as sources of information, (5) 100% teachers provide structured tasks to students in and out of class, (6) 100% teachers give awards and / or sanctions to students, (7) 66.67% teachers optimize the use of learning media, and (8) 33.33% teachers using ICT media as a means of delivering information to learners in the learning.

Based on the observation result toward the 4th grade students of SD Negeri Tegalrejo 01 Salatiga, obtained data: (1) 100% students state that they have used textbooks and other sources related to learning materials as source of information, (2) 90% students respond to structured tasks by teacher in and out of the class, (3) 100% students have responses of

awards and / or sanctions, (4) 75% students are motivated to focus during the learning, (5) 50% students also optimize the use of learning media, and (6) 20% students using ICT media as a means of delivering information in the learning.

Based on both of preliminary study results toward 6 teachers and 4th grade students of SD Negeri Tegalrejo 01 Salatiga, the development of MITRA learning model of problem solving-based to solve mathematical tasks are able to handle, then, not only teachers but also students that they like to use ICT media as means of delivering information. The using of ICT media are a means or an alternative for teacher in deliver the material to learners. Students are able to use ICT as a facility that can help them to grow their high-order thinking skills (HOTS) in learning mathematics especially on fractions material. And, currently the students' interest against ICT especially Smartphones is very high and seem not possible without the existence of Smartphone and difficult to avoid, and teachers can assist to guide the students' in using Smartphone in a positive way.

The development process produces a product model of MITRA of problem solving-based. MITRA Problem solving-based learning model is a learning model that contains solutions to a problem through interactive multimedia with the use of ICT in Android operating system of Smartphone. The learning covers the process by using examples of programs with problems or problems for students learn. Students may use the process to develop solutions.

MITRA Problem solving-based learning model is developed with the goal of education: each student has an understanding of the problem solving process, and appreciated the value of the problem solving process of learners to themselves. Cognitively, students can explain the problem-solving process by showing the use of problem-solving processes. Affectively, Students can appreciate the use of problem-solving processes by evaluating their effectiveness in achieving learning objectives. Thus, MITRA Problem solving-based learning model is able to provide an authentic learning experience to learners, and then effectively it may apply in the process of learning mathematics in Elementary School using Smartphone of Android operating system.

The syntax of MITRA learning model of problem solving-based, are: (1) Problem Identification, this step requires students to identify the irrelevant or inadequate information

in problem solving, or to identify the answered questions following the rules by the teacher; (2) Implement the MITRA, this step is required to select a solution based on correct consideration as a form of problem solving, that is through MITRA; and (3) MITRA evaluation, this step requires students to re-identify the problems that can be solved in the same way as the previous problem, to determine the effects of various conditions on a particular problem, or to evaluate the strategy of the solution.

The advantages of MITRA learning model of problem solving-based are: (1) fun and interactive, and it may stimulate the students to grow high-order thinking ability (HOTS); (2) solve the difficult topics until the arranged the pieces of information; (3) help to improve students' understanding of various topics of problem solving; (4) students may learn to practice various skills; (5) developed in accordance with the applicable national curriculum; (6) combining the colors and visual approaches to learn with simple informative content, then provide a highly effective students' learning experience; (7) containing a theory evolution, and it may help students to reflect fast thinking, control of emotion, supportive, and creative in managing the strategies that influence the students' behavior; (8) helping the students to new experiences; (9) helping the students to develop the learning objectives; (10) increasing the self-esteem of students in understanding themselves as a whole.

The implementation steps are by: (1) preparing the syllabus of 4th grade students of mathematics in elementary school; (2) selecting and determining KD (fractional material), and (3) developing an RPP that contains MITRA learning model of problem solving-based.

MITRA learning model of problem solving-based is presented in the form of application with format .apk. The following figures are some of MITRA.apk display.



Figure 2. Opening Page

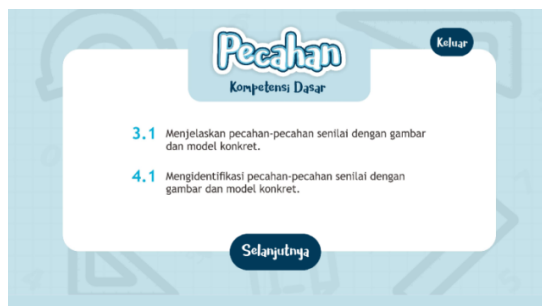


Figure 3. Basic Competence Page

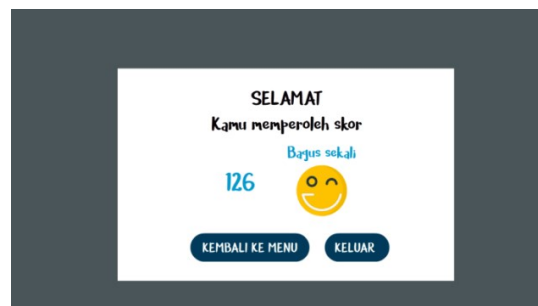


Figure 8. Score Page

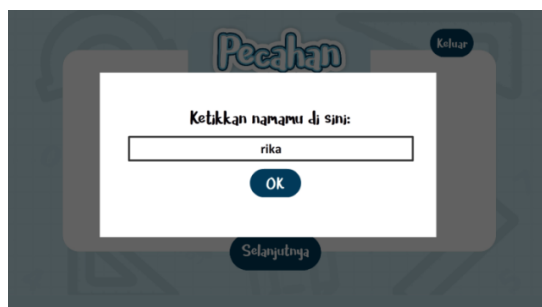


Figure 4. Name Input Page



Figure 5. Main Page Display



Figure 6. Interactive Content Page

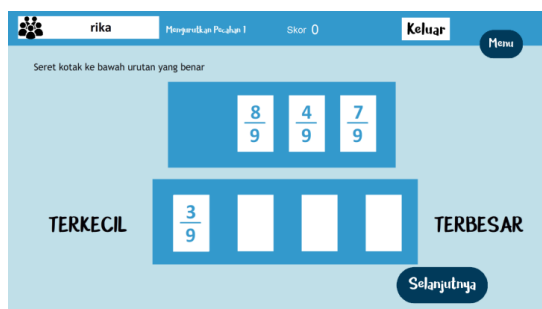


Figure 7. Evaluation Task Page

The success of the research to determines the steps because there are previous theories about the model of learning. Learning model according to Darmadi (2017); Rusman (2010); Trianto (2010), is a planning pattern in the learning that will be implemented by the teacher, contains: learning objectives, learning steps, learning environment, and management. I also agree with the characteristics of the learning model according to Suyanto & Asep (2014, p. 137), which are: having a systematic procedure, specially formulated the learning outcomes, specific environmental setting, success measure, and interaction with the environment. And then, the success of learning through MITRA learning model of problem solving-based also has function in accordance with the function of learning model according to Suyanto & Asep (2014, pp. 137–138) by Chauhan, the functions of learning are: guidance, curriculum development, placement of learning materials, and improvement learning.

Second, the successful development of the steps of MITRA learning model of problem solving-based is related to the theory of learning model of problem solving. I agrees with Bey & Asriani (2014, p. 226); Gora (2010, p. 94); Sulasmono, (2012, p. 162), and Hanlie Murray, et all in Huda (2013, pp. 273–274), the learning model of problem solving is a learning model that presents a contextual problem and it may able to stimulate the students to practice and learn to solve the problem logically. The goal is to provide stimuli in the form of problems, and the students able to solve the problem, as impact, the student add skills in achieving learning materials (Darmadi, 2017, p. 118).

Third, the research result entitled “The Influence of Problem Solving Model with the Assisted of Snakes And Ladders Game to Student Mathematics Knowledge Competency” by Maretayani, Wiarta, & Ardana (2017) with average result 72.77 by applying problem solving model assisted by media of snakes and

ladders. It supported the researcher's research that the learning model of problem-solving of media-assisted may be resulted in validated research, and it is practically applied in SD.

Fourth, the last step in pursuing the steps of MITRA learning model of problem solving-based, I refers to the syntax of problem solving learning model according to Bey & Asriani (2014, p. 226), six steps problem solving process (www.cls.utk.edu), Darmadi (2017, p. 235), Deb Russel in (Huda, 2013, pp. 274–275), and Lafedin (2014, pp. 235–236), and, I determine the steps: (1) problems identification, (2) implement of MITRA, and (3) evaluates of MITRA.

The validity level of MITRA learning model of problem solving-based based on material expert gained average score of 3.75 and average percentage was 75%, meanwhile, by media expert gained average score of 214 and average percentage was 76.5%. Thus, according to the percentage of score, it may conclude that the product was in the high category (see Table 1). In sum, the MITRA learning model of problem solving-based may state to be qualified as form of problem solving for elementary mathematics learning.

Table 1. Validation Test Category

Interval	Category
81 – 100%	Very High
61 – 80%	High
41 – 60%	Medium
21 – 40%	Low
1 – 20%	Very Low

The success of the research to obtain high category in the validation process by material experts because there is a mathematical science according to Ismunamto (2011, pp. 15–17), Van de Walle (2008, p. 13), and Suhendri (2011, p. 32). In addition, I also did not make own material, and is guided by the basic mathematics competence for elementary school which is contained in the Document of Ministry of Education and Culture 2013, and then, it get the material and submaterial of fractions.

The success of the research to obtain high category in the validation process by media expert refers to interactive multimedia theory according to Maryani (2013, p. 19); Munir (2012, p. 2), and Wikipedia's Android theory cited by Aziz (2012); Hidayat & Sudarma (2011, p. 192); Kusuma (2011); Rahadi (2014, p. 662).

The result of the research entitled "Developing Mathematics Learning Tools to Support Character Education on Fourth Grade Students of Primary School" by Fauziyah & Jailani (2014), which produce an interactive multimedia learning tools to support the character education on fractional materials with feasible results with categories quite valid, practical, and effective. The research result makes the researcher of the research do research to develop MITRA learning model of problem solving-based to solve mathematics problems on elementary school. The researcher also took the material and submaterial of fractions, and as impat, it obtained validity results in the high category.

Another research results are: (1) entitled "Developing Multimedia Learning Mathematics on Integer Matterial of Class IV SDN Lempuyangan I Yogyakarta" by Fredy & Soenarto (2013) with test result of  $T_{count}$  is bigger than  $T_{table}$  ( $4.034 > 2.01$ ), and n-gain test result  $0.57 > 0.42$ , means the learning outcome of experimental class was higher than control class, and the use of multimedia effectively improved the students' learning outcomes; (2) entitled "Implementation of Interactive Multimedia-Based Learning Media on Mathematics Subjects in Elementary School" by Paseleng & Arfiyani (2015), the result that interactive multimedia-based learning media can bring a positive effect on the students' learning interests; (3) entitled "Designing and Developing Mathematics Learning Application on Measurement of Time, length and Weight for Grade 2 Primary School" by Putra & Pujiyono (2014), the result that interactive multimedia of mathematics learning about time, length and weight measurement for Grade 2 classroom can be used as learning support media for teachers and students of elementary school 2nd grade; (4) entitled "Mathematics Learning Materials of Cuboids Solid Figure with Interactive Multimedia Applications at SD Negeri Teguhan, Sragen" by Hartanto (2013), the result that the students felt interesting to learning and more easier in understanding the mathematics material with interactive multimedia; and (5) entitled "Developing system of Mathematic learning Visualization of Multimedia-Based for Elementary Students" by Saefudin & Ekasari (2015), received positive responses in math learning with the assist of mobile devices such as Smartphone and tablets, then the implementation of developed applications can help

students in learning. The five previous studies also become the reference for particular research although the five studies do not discuss on fractional materials. But, I agreed in the selection of subject mathematics, the use of interactive multimedia, and applied in SD, In fact, the results are feasible to use in learning.

The discussion of effectiveness level of MITRA learning model of problem solving-based is viewed from the pretest and posttest result on Table 2.

The data analysis technique used Wilcoxon test software-assisted SPSS (Statistical Product and Service Solution). Wilcoxon test is a nonparametric statistic test which can be used to test the hypothesis if the prerequisite test has been fulfilled (Purnomo, 2015, p. 185). If the hypothesis is formulated:

$$H_0: M_{\text{posttest}} \leq M_{\text{pretest}}$$

Median of Mathematics learning outcomes after learning using MITRA learning model of problem solving-based are lower or equal to before learning.

$$H_a: M_{\text{posttest}} > M_{\text{pretest}}$$

Median of Mathematics learning outcomes after learning using MITRA learning model of problem solving-based are higher than before learning.

Wilcoxon test results show that the MITRA learning model of problem solving-based is included in the score Asymp. Sig. (2-tailed) < 0.05 then H0 is rejected and Ha accepted ( $M_{\text{posttest}} > M_{\text{pretest}}$ ) ie: Test Statistics output, and known that score Asym. Sig. (2-tailed) of 0,000 and the score of Z is -4.903 are presented in Table 3.

Table 2. Pretest and Posttest Result

No.	Interval Class	Pretest Score		Posttest Score	
		F	%	F	%
1	≤20	0	0%	0	0%
2	20-40	0	0%	0	0%
3	41-60	0	0%	0	0%
4	61-80	15	40%	1	3%
5	81-100	23	60%	37	3%
Total		38	100%	38	97%

So, the mathematics learning outcomes after learning using MITRA learning model of problem solving-based is higher than before learning. The category refers to the posttest result (3% in intervals of 61-80 and 97% in the interval of 81-100) that is in the average of interval class of 81-100, and, it is very effective as presented in Table 4.

Table 3. Test Result of Wilcoxon

		Ranks		
		N	Mean Rank	Sum of Ranks
Posttest - pretest	Negative Ranks	1(a)	6,50	6,50
	Positive Ranks	32(b)	17,33	554,50
	Ties	5(c)		
	Total	38		

a posttest < pretest

b posttest > pretest

c posttest = pretest

Test Statistics (b)	
posttest – pretest	
Z	-4.903 (b)
Asymp. Sig. (2-tailed)	.000
a. Based on negative ranks.	
b. Wilcoxon Signed Ranks Test	

Table 4. Effectiveness Level Category

Interval	Category
81 – 100%	Very Effective
61 – 80%	Effective
41 – 60%	Enough effective
21 – 40%	Less effective
1 – 20%	Not effective

Thus, the students' mathematical of problem solving ability and disposition who acquired the MITRA learning model of problem solving-based is better than students who acquired using only interactive multimedia or using only problem solving learning model.

### Conclusion

Based on the results of the study and discussion, it concluded that: (1) steps of MITRA learning model of problem solving-based to solve the elementary mathematics tasks can be implemented by the steps of: problems identification, implement of MITRA, and evaluates of MITRA; (2) product's validity level of MITRA learning model of problem solving-based according to expert's validation was 3,75 (75%) on high category, and the media expert was 214 (76,5%) on high category; and (3) product's effectiveness was on very effective category for students of grade 4 elementary school reaching 97%, and the result was significantly higher than pretest (60%).

The suggestion to use the product of MITRA learning model of problem solving-based to solve the elementary mathematics, are: (1) learning by using MITRA learning model of problem solving-based to solve the elementary



mathematics provide higher learning outcome compared to learning without using the model; therefore, strongly suggested for teachers to use MITRA learning model of problem solving-based to solve the mathematical, especially on fractional materials; (2) using MITRA.apk product with teacher guidance or parent counseling to students, in order the content are able to gain by learners maximally; (3) for writers and for researchers who interested in the results of the research and development it may become a reference in conducting further research and development.

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