The need analysis development of mathematics learning model based realistic mathematical education and literacy in junior high school

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Abstract

The research was due to Indonesian students' literacy in mathematics was unsatisfying according to Programme for International Student Assessment. The aim of this research is to analyze main necessities which grounded the prominence to develop a learning model. This research belongs to descriptive study. Based on data analyzed, the findings reveal that 1) the teachers' knowledge about mathematical literacy was low, 2) the learning approach still did not related to the material with the context of students' daily lives, 3) the average value of students' mathematical literacy was 31.87 be classified into low category, and 4) the assessment instruments was far from the mathematical literacy, 5) realistic mathematics education approach ever developed by researchers in learning mathematics has not been combined with the concept of literacy. Based on these findings, the researcher needs to develop mathematics learning model based on realistic mathematical education and literacy in junior high school.

Keywords: need analysis, realistic mathematical education, mathematical literacy

Introduction

The research was due to Indonesian students' literacy in math was unsatisfying according to Programme for International Student Assessment (PISA). The mathematical representation of Indonesian students since the first Indonesian participation in PISA in 2000 until 2015 never progressed far below the international average (Table 1). The result indicates that more less nine years of mathematics learning students of Indonesian were not able to solve mathematical problems in daily life, they were not aware of mathematical phenomena around them as well.

The objective of PISA is to evaluate education systems worldwide by testing students' knowledge and skills in math, reading and science (Lin and Tai, 2015). PISA assessment is useful in recognizing the level of students' math skills in some countries, as well as for understanding the strengths and weaknesses of the education system in the countries involved in PISA (Kusumah, 2011). One indicator that shows the quality of education in the country tends to be low is the result of an international assessment of student achievement (Wardhani and Rumiati, 2011: 1). Thus, it can be concluded that the low mathematics achievement of Indonesian students according to the PISA international institution survey reflects the low quality of education in Indonesia, including mathematics education.

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Table 1. Achievement of Indonesian Student Mathematics According to PISA

Year	Indonesian		Number of Participant Countries	International Average Score
	Scor	Rank		
2000	367	39	41	500
2003	360	38	40	500
2006	391	50	57	498
2009	371	61	65	496
2012	375	64	65	494
2015	386	63	70	490

Sumber: OECD

There are several fundamental issues related to the quality of education in Indonesia, namely: 1) the learning process in educational institutions that are too oriented to the mastery of the theory and memorization on all subjects, thus causing the learning ability and reasoning less developed students; 2) a highly structured and load-bearing school curriculum that causes the learning process in school to be sterile on the evolving state and environmental changes in society; 3) educational outcomes can not yet be assessed through a reliable and institutionalized test or assessment system (Hasbullah, 2015: 18).

Associated with mathematics education in particular, some of the problems found are: 1) the approach in mathematics learning is very mechanistic and conventional; 2) learning process is only focused on learning objectives and learning outcomes, while the process to arrive at learning outcomes neglected. Most learning objectives focus only on remembering facts, concepts and other aspects of computing; 3) change and innovation in learning mathematics does not solve both problems, because change and innovation is far from implementation strategy (Fauzan, 2002).

The concept of assessment of students' math skills in PISA is literacy. The low mathematics achievement of students in PISA illustrates the low level of student math literacy. According to Indonesia PISA Center, the causes of the low literacy of Indonesian students' mathematics are: 1) Weak problem solving abilities of non-routine or high level; 2) An evaluation system in Indonesia that still uses low level questions; 3) Students are accustomed to acquire and use formal mathematics knowledge in the classroom. In order to improve students' mathematical literacy, teachers, governments and educational observers need to understand first what mathematical literacy is, and need to be aware of why mathematical literacy needs to be a concern in mathematics learning.

Mathematical literacy is defined as a person's ability to formulate, apply, and interpret mathematics in a variety of contexts, including the ability to do mathematical reasoning and to use concepts, procedures, and facts to describe, explain, or predict phenomena. Mathematical literacy helps one to understand the role or usefulness of mathematics in everyday life while using it to make appropriate decisions as a building, caring, and thinking citizen (OECD, 2013, p 17).

Mathematical literacy does not merely include the ability to execute a number of ways or procedures, and possess basic mathematical knowledge that enables a member of society to live in difficult situations, and simply with what they need. Mathematical literacy also includes mathematical knowledge, methods and processes, which are utilized in various contexts in ways that inspire and open up thinking insights (de Lang, 2003). Put simply, mathematics literacy is knowledge to know and apply basic mathematics in our everyday living (Ojose, 2011, p. 90). Mathematics literacy means to have the power to use mathematical thinking to solve real-world problems (Stacey and Turner, 2015, p.13). Thus, it can be concluded that mathematical literacy is not limited to a person's ability to solve math problems itself, but includes the ability of a person to use his mathematical knowledge to solve mathematical problems in the real world or in everyday life in various contexts.

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Mathematical literacy should be socialized in school learning because mathematics literacy is the knowledge to know and apply basic mathematics in our everyday living (Kusumadhani et al, 2015). Matehmatic literacy can provide benefits to education and prepare citizens to live a daily life more productive (Stacey and Turner, 2010). In life in this modern age, everyone needs to have the mathematical literacy to use when dealing with problems, since mathematical literacy is very important for all people associated with work and duties in everyday life (Kusumah, 2011). Mathematical literacy will encourage a person to be sensitive and understand the use of mathematics in the daily life of Sari (2015: 718). From some of the above opinions, it is clear that the mathematical literacy needs to be a concern in the learning of mathematics in schools, so that students are able to use their mathematical knowledge to solve math problems in everyday life, as well as introduce to students the relevance of mathematics subject matter to students' real life. Thus, it is expected that students' math learning motivation will increase when students know the benefits of mathematics in their daily lives.

Knowledge of math literacy is also important for teachers to be able to design lesson-based learning and literacy assessment instruments. This is because the successful achievement of students' mathematical literacy competency will be determined by the ability of teachers to develop and use the measured mathematical literacy tools in the right way, and the ability to analyze the information produced by the measuring instrument (Pulungan, 2014). The ability of teachers in designing learning and instrument based on literacy assessment, students are expected to be accustomed to working on literacy-charged questions, which indirectly train students to be able to solve math problems in everyday life as well as to give sensitivity to students to mathematical phenomena that are around they. This is based on the Law of Exercise and Repetition of Edward L. Thorndike in Connectionism Theory which states that something will be very strong if it is often done exercise and repetition (Riyanto, 2012: 7).

Several attempts have been made by teachers and researchers to improve students' mathematical literacy. Among them are applying various new models or approaches in learning mathematics in schools such as, Realistic Mathematics Education, Contextual Teaching Learning, Problem Based Learning, Problem Solving, and Open-Ended Approach. In the learning approach students are exposed to contextual problems that will help them construct their knowledge. At this stage students will use their literacy skills to formulate real problems into mathematical problems, then solve them and interpret them in a real context. In this way they use their mathematical literacy skills as well as develop them (Sari, 2015, p. 718). However, in the period of 2000, since the first Indonesian participation in PISA, until now not so visible improvement in mathematics achievement of Indonesian students according to international survey institutions, such as PISA. This of course can be caused by many factors. However, the solution to the above-mentioned problem needs to be sought.

To find alternative solutions to this problem, needs to be analyzed needs and context in the field. The purpose of this study is to analyze the needs and context in the field based on the development of learning models that are able to answer the problems and needs.

Method

The type of this research is descriptive research. Descriptive research is a research method that tries to describe and interpret the object as it is. Descriptive research is generally done with the main purpose of describing the systematic facts and characteristics of the object or subject that is examined appropriately (Sukardi, 2004).

Objects in this study are teachers of mathematics, students, learning process, assessment instruments and related research results. Mathematics teachers are used to obtain information about the model or approach that teachers apply in mathematics learning, as well as teachers' knowledge of

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mathematical literacy. There were seven mathematics teachers from five Junior High Schools in Bukittinggi who were interviewed to get this information.

Students are used to obtain information about students' mathematical literacy skills in Bukittinggi, and to find out the needs of students in learning. For this purpose the selection of schools is done by purposive sampling. Purposive sampling is a technique of determining the sample with certain considerations (Sugiyono, 2010, p.124). The school consideration chosen as a sample is a superior school. In this case the selected school is SMPN 1 Bukittinggi with the number of students involved as many as 62 students of class IX.

The process of learning is observed to find out how the implementation of mathematics learning in the classroom. Observations were made in several classes VII, VIII and IX in five schools. Teaching materials, assessment instruments and related research results are used to obtain information about the characteristics and the content of the literature they contain. The assessment instruments are analyzed in the form of even grade semester examination of class VII and class VIII, and the exam of school in class IX TP 2025/2026. The results of the research were analyzed in the form of a dissertation on the Development of Geometry Based Learning Model of Realistic Mathematics of SMPN Kota Padang (Musdi, 2012).

Researchers use interviews, questionnaires, observations, math literacy tests and documentation as data collection techniques. Documents used in the form of assessment instruments and related research results. The instruments used in this research are interview guide, questionnaire for students, observation sheet, literacy test sheet and document assessment sheet. Technique of data analysis in research use descriptive statistical analysis. Descriptive statistics are statistics that serve to describe or provide an overview of the object under study through sample or population data as they are, without analyzing and making conclusions that apply to the public (Supardi, 2013, p.31). Data descriptions are performed using tables, diagrams and group descriptions through concentration measures, such as mean, median, mode, and diversity sizes such as range, variance and standard deviation.

Results and Discussion

Mathematics literacy tests conducted on 25th and 31st August 2016 to 62 students of grade ninth at SMPN 1 Bukittinggi got the average result that only 36.24% of the questions could be answered by the students correctly, with an average score 31.87 (Figure 1). These results indicate that, although SMPN 1 Bukittinggi is a superior school, but the students' math literacy is low. Based on this result, it can be concluded that the mathematics literacy of junior high school students in Bukittinggi is still relatively low.

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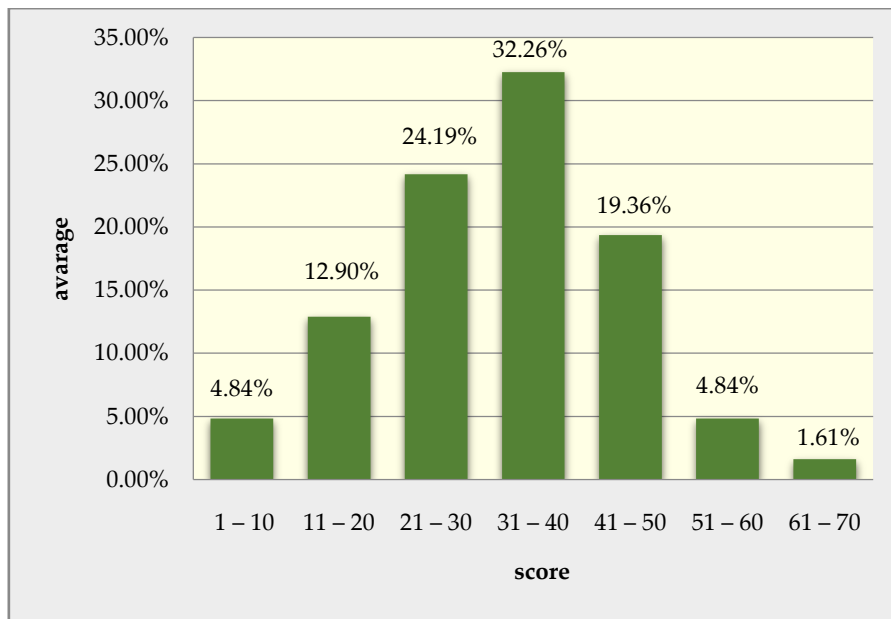
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Figure 1. The Score of Mathematical Literacy of The Students of Grade Ninth of SMPN 1 Bukittinggi

Based on the level of mathematical ability, the percentage of the students in math literacy tests was more at level 3 down and very little at level 4 up, especially at level 5 and 6 (Figure 2). If it was compared to Bloom's cognitive level, the questions at level 1-3 belong to questions that require low order thingking skills, while level 4-6 questions are the ones that measure the level high (high order thingking skill) (Setiawan, 2014). These results indicated that students were not able to master high-level questions, namely those that required high order thinking skills with the context which was unknown by the students, or nonroutine test.
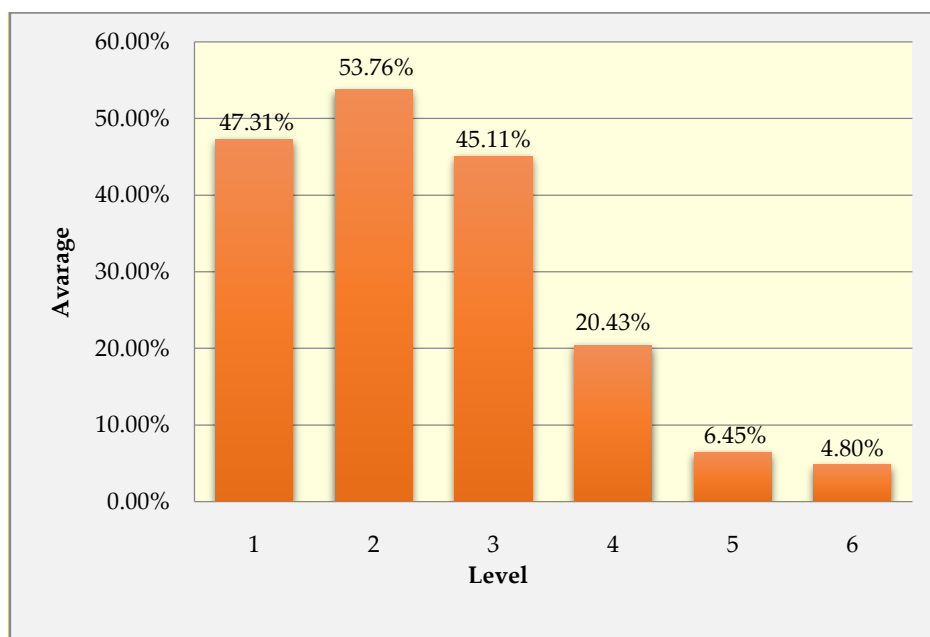

Figure 2. Percentage of students' math ability level

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Based on the questionnaire distributed to the students who did the test, it was revealed that 94.76% of the students stated that they had never taken such type tests in school. This proved that the students were rarely given the math literacy tests. The results of the questionnaire also gave an information that almost all students answered they needed a learning model that could facilitate them to be able to do such kind of tests.

Based on the interviews with seven mathematics teachers from five state Junior High Schools in Bukittinggi on June 15th=th thtt, 2016, it was found that teachers' knowledge about mathematics literacy, especially the PISA model mathematics literacy, was lack . 85.71% of teachers interviewed had never heard of the term literacy mathematics. Only 14.29% teachers ever heard the term mathematical literacy through seminars that had been followed, but they did not recognize how the PISA model mathematics literacy scheme was scored. This problem made the teachers did not know the competence of mathematics literacy, so the learning models and the assessment instrument of learning results designed by teachers were not based on literacy yet.

Based on the result of the analysis toward the mathematics learning result instrument designed by the Junior High School mathematics teachers in Bukittinggi, it was found that the assessment instrument was far from the content of the literacy, in terms of the context, the process and the cognitive level of the students. This could be observed from the questions of mid-semester exam, final exam or school exam. The result of the analysis on the even semester exams and school exam in mathematics at SMP Negeri mathematics in Bukittinggi academic year 2015/2016 was more on the direct calculation without the context, less revealing the thinking process of the students and even more dominated by the questions at level 1, the questions are given explicitly and all the data required to do the test was given appropriately (Table 2).

Table 2. Literacy content of Even Semester Exam and School Exam Lesson Mathematics

State Junior High School in Bukittinggi academic year 2015/2016

		Exam Even Semester				School exams	
		Grad Seventh		Grade Eight		Grade Ninth	
Type of Test		Multiple Choice		Multiple Choice		Multiple Choice	
Number of Problems		40		40		40	
Details of The Test		Σ	%	Σ	%	Σ	%
Context Components	Personal	6	15	2	5	6	15
	Societal	5	12.5	2	5	3	7.5
	Occupational	1	2.5	1	2.5	1	2.5
	Scientific	-	-	-	-	-	-
	Total	**12**	**30**	**5**	**12.5**	**10**	**25**
Process Components	Formulate	2	5	6	15	6	15
	Employ	36	90	34	85	32	80
	Interpret	2	5	-	-	2	5
Level	6	-	-	-	-	-	-
	5	-	-	-	-	-	-
	4	-	-	-	-	-	-
	3	-	-	1	2.5	-	-
	2	4	10	2	5	-	-
	1	36	90	37	92.7	40	100

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Based on the classroom observations conducted between July and August 2016 at five State Junior High Schools in Bukittinggi, it was found that the teaching approach applied by the teachers tended lack of relating to mathematics material in the real life context of the students. This gave the impression that math was separate from one's life. As a result when students were exposed to mathematical problems in the real life, they were difficult to solve because they were not accustomed to dealing with contextual issues. This philosophy was referred to by PISA (mathematical literacy), that mathematics is not a science isolated from human life, but mathematics arises from and useful for our daily life (Wijaya, 2012: 2).

Analysis on the results of research in the form of a dissertation on the Development of Learning-Based Geometry Model Mathematics Realistic SMPN Padang conducted by Musdi (2012) obtained the following information. Musdi used 3 pieces of evaluation, namely Individual Worksheet, Advanced Training Sheet and Evaluation Sheet of Learning Results.

Therefore, the researcher found that Evaluation Sheet used by Musdi as one of his Research Instruments, which was designed to obtain the data on learning completeness as the main data of effectiveness of realistic mathematical education model, was still far from the mathematics literacy of the characteristics of the PISA model. The results of the analysis on Individual Worksheet gave the results that the problems designed were limited to the Personal and Societal context, it did not contain the Interpret process, and only measured the students' ability until level 3, and more questions at level 1 (Table 3). Similar results were also found on the Advanced Exercise Sheet, where the questions gave did not show the Formulate and Interpret process, and all questions were at level 1.

Tabel 3. Literacy content Individual Work Sheet

		Individual Work Sheet						
		I	II	III	IV	V		
Number of Problems		4	3	3	2	3	Total	%
Context Components	*Personal*	1	1	1	-	1	4	26.7
	Societal	2	1	1	-	1	5	33.3
	Occupational	-	-	-	-	-	-	0
	Scientific	-	-	-	-	-	-	0
Process Components	*Formulate*	2	2	-	2	-	-	40
	Employ	2	1	3	-	3	-	60
	Interpret	-	-	-	-	-	-	0
Level	6	-	-	-	-	-	-	0
	5	-	-	-	-	-	-	0
	4	-	-	-	-	-	-	0
	3	1	-	-	-	-	1	6.7
	2	1	2	-	-	-	3	20
	1	2	1	3	2	3	11	73.3

The results of this dissertation analysis showed that the researchers and teachers who applied and developed PMR-based mathematics learning in schools did not have insight about PISA model's mathematical literacy. Although, implicitly the realistic mathematical education aims to improve students' mathematical literacy, the lack of the researchers' and teachers' knowledge towards the mathematical literacy of PISA model, cause the lack of their ability in developing learning materials and assessment instruments contained literacy.

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Conclusions

Based on the data analysis that was done, obtained some findings from the analysis of needs and context in the field, namely 1) the teachers' knowledge about mathematical literacy was low, 2) the learning approach still did not related to the material with the context of students' daily lives, 3) the average value of students' mathematical literacy was 31.87 be classified into low category, 4) the assessment instruments was far from the mathematical literacy, 5) realistic mathematics education approach ever developed by researchers in learning mathematics has not been combined with the concept of literacy yet. Based on these findings, the researcher needs to develop mathematics learning model based on realistic mathematical education and literacy in junior high school.

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