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ENCHANCING STUDENT'S MATHEMATICAL PROBLEM SOLVING ABILITY AND SELF-REGULATED LEARNING BY USING REALISTIC MATHEMATICS EDUCATION

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Abstract

This article reported the findings of an experiment research having a goal to enchance students' mathematical probelm solving ability (MPSA) and self regulated learning (SRL) by using realistic mathematics education (RME). Subjects of this research were 60 seventh grade students of a Yunior High School in Garut, and the instruments this research were an essay MCTA test, and a SRL scale. The research found that the grades of MPSA of students getting treatment with RME were higher than the grades of students taught by scienctific approach, however those grades were at low grades qualification. In addition, there were no different grades on student's SRL. Beside that, stdudents in both classess still encountered difficulties on solving MPSA tasks, and there was no association between student's MCTA and student's SRL.

Keywords: Problem Solving Ability, Self-Regulated Learning, Realistic Mathematics Education

Abstrak

Artikel ini melaporkan temuan penelitian eksperimen yang bertujuan untuk meningkatkan kemampuan pemecahan masalah matematika (MPSA) siswa dan pembelajaran mandiri (SRL) dengan menggunakan pendidikan matematika realistik (RME). Subjek penelitian ini adalah siswa kelas VII SMP Garut yang berjumlah 60 siswa dengan instrumen penelitian berupa tes essay MCTA dan skala SRL. Hasil penelitian menemukan bahwa nilai MPSA siswa yang mendapatkan perlakuan RME lebih tinggi daripada nilai siswa yang diajar dengan pendekatan ilmiah, namun nilai tersebut berada pada kualifikasi nilai rendah. Selain itu, tidak ada nilai yang berbeda di SRL siswa. Selain itu, siswa di kedua kelas masih mengalami kesulitan dalam menyelesaikan tugas MPSA, dan belum ada hubungan antara MCTA siswa dengan SRL siswa.

Kata Kunci: Kemampuan Pemecahan Masalah, Pembelajaran Mandiri, RME

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INTRODUCTION

Basically, mathematical problem solving (MPSA) is an essential mathematical ability should be mastered by and improved on high school students. There are two important reasons underlying the statement. The first reason is: MPSA is listed in the goals of teaching mathematics including: To understand mathematical concepts and applying them in problem solving; The second reason is well known conception of mathematics expert, namely: MPSA

is a main mathematics ability in learning mathematics, even if it is the hart of mathematics teaching (Branca, 2005, as cited in Hendriana, Rohaeti, Sumarmo, 2017). There are many writers explain the meaning of problem solving term in different expressions. However, the definition contains a similar notion such as: a. problem solving is a process that does not have a standard way of resolution (Polya, 1985); b. Problem solving is a process of implementing previous concepts or skill for solving an unknown condition problem (Krulik and Rudnik, 1995).

Although MPSA is so important, at this time there are still many students who have not mastered MPSA as we hoped. This situation is ilustrated in findings of some studies (Krismayanti, Sumarmo, Maya, 2018, Romlah, Sumarmo, Syaban, 2019, Pujiastuti, Kusumah, Sumarmo, Afgani , 2014) that reported students taught by ordinary teaching obtained MPSA at low grade qualification, and students getting treatment with different innovative teaching approaches attained MPSA at moderat grade level. Those findings ilustrated that MPSA was difficult taks for many high school students, and it was predicted caused of MPSA was classified as high order thinking (HOT) skill in mathematics. To solve MPSA well, beside students should have mastered the mathematics content and they should have positive behavior in solving difficult mathematics tasks as well, for examples: having desire to learn and to organize their own learning, control their own learning outcomes and like to work together in small groups. Those positive affective behavior are part of a well known behavior term that is self regulated learning (SRL).

Some writers elaborate SRL term in different expression but they have three main smiliar components those are: to set his own learning; to observe and to assess learning outcomes, and to compare them to a certain standard. Some studies (Romlah, Sumarmo, Syaban, 2018, Krisnawati, Rohaeti, Maya, 2018, Retnaningsih, Sugandi, 2018) reported that by using different teaching approaches students attained SRL at fairly good grade level. Such student's affective behavior were in accordance with what we expect. Seemingly, for many students it were more difficult to solve MCTA tasks than to behave SRL.

With regard to teaching and learning process, Polya (1975) argues that the task of the teacher is not only to convey teaching material, but the more important are to create a class learning atmosphere so that encouraged students to present their ideas in their words, and to motivate student to think well. Besides that, Indonesia mathematics curriculum, 2013, suggested that mathematics ability and affective behaviour such as MCTA and SRL should be improved at the same time. This suggestion motivated researchers to examine some learning approaches that meet with the Polya's conception and curriculum expectations. We predict that realistics mathematics education (RME) will be in accordance with afformentioned expectations.

Feudenthal (as cited in Fathurrohman, 2015) explaines that RME is an approach oriented on mathematizing of contextual situation in daily live. Further, by observing, anlyzing, and infering the real situation student reinvented mathematics concept involved in that situation. Two studies (Murni & Sugandi, 2018, Palinusa, 2017) reported the superiority of RME than ordinary teaching in improving student's critical thinking ability and mathematical resilience.

Those afformentioned arguments and findings motivated researchers to excecute a study to analyze the role of RME on obtaining student's MPSA and SRL, and then we compile research questions as follow.

1. Are MPSA grade and its normalized gain, and SRL grade of students getting treatment with RME better than the grades of students taught by Scientific Approach?
2. What are student's difficulties on solving MCTA tasks?

3. Is there any association between MCTA and SRL?
4. What are student's activities during the RME lessons?

In addition to the explanation of MPSA that has been described previously, there are some arguments discussing MPSA in more detailed. Base on the step of solving problem, Polya (1985) propose the steps of MPSA, as follow : a. First, understand the problem inculded: to identify information that is known and asked, to check the adequacy of information for solving the problem, b. To compile mathematical model of the problem, c. To sellect strategy to solve the mathematical model, and to test the truth of the solutions obtained. Further, Polya (1985) proposes some steps in solving MPSA task such as: To formulate the problem in a simpler form; To draw a picture or to compile table, to formulate pattern of the known information, to break down the main problem into sub-problems, to excecute enumeration accompaied with the rules used, and work backwards. Other writers, Muijs and Reynolds (2005) put forward a number of suggestions for solving problems, namely: to make relate among the known information, to formulate the relationships into mathematical models, to scaffold the model, to train sovilng the mathematical model, to write the settlement into language that is easily understood, and to reflect on the work already done.

Some writers elaborate SRL in more detail as follow: a. SRL is a process of designing and observing learning process in solving academic tasks (Hargis and Kerlin, 1992); b.SRL is habit to observe one's own behavior, setting learning goals, and working hard. (Bandura as cited in Hargies, and Kerlin, 1992), c. SRL is learning process guided by thinking, feeling, strategy, and own behaviour in realizing goals, and it involves three phases namely: to design learning, to observe learning activities, and to assess learning outcomes and to compare them with certain standards (Schunk and Zimmerman, 1998); d. SRL is self-regulated learning in designing, implementing, and assessing their own learning.

Further, some writers put forward suggestions for improving SRL among other as follow: a. Help students carry out the SRL cycle flexibly and adaptively (Butler, 2002, as cited in Sumarmo, 2006, 2011); b. Make student realize on the meaning and the importance of having SRL; Perform teacher and familiarize students to behave as expected in SRL; Carry out integrated and continous mathematics teaching-learning process (Sauri, 2010).

Freudenthal (as cited in Fathurrohman, 2015) explaines that RME is an approach oriented on mathematizing of contextual situation in daily live. Further, by observing, anlyzing, and infering the real situation student reinvented mathematics concept involved in that situation.There are two main perspective and three key principles in RME (Freudenthal, as cited in Fathurrohman 2015). The RME perspectives are: mathematics should be connected to reality and mathematics should be seen as a human activity; and the three principles were: guided reinvention, didactical phenomology, and self developed models. Then Gravemeijer (1994, as cited in, Pallinussa, 2013) adds those principles with progressive mathematizing.

With respect to Freudenthal's principles, Travers and Gravemeijer (as cited in Pallinusa, 2013, Wijaya, 2012) suggest that RME has five principles namely: a) Utilizing contexs, b) Applying models in progressive mathematization; c) Utilizing student's construction; d) Interactivities; and e) Intertwining. Further, Treffer (as cited in Fathurrohman 2015) proposes that in RME we distinguish there were two kinds of mathematization, those are: horizontal and vertical mathematization.

Similar to other types of learning, RME also has advantages and disadvantages. Suwarsono (as cited in Hadi, 2009) poses some advantages of RME such as: a. To relate between

mathematics and daily live activities, b. Mathematics is constructed and improved by students their selfes; c. Mathematics is opened-ended process; d. RME combines advantages of other approaches based on constructivism philosophy such as problem based learning, problem based environment, and contextual teaching. While some disadvantages of RME among other things are: a. It is no easy to find good contextual problems for certain mathematics topic; b. Assessment in RME is more complicated than in conventional teaching; c. To select relevant learning media should be carefull, so that it realy help student to think.

Apart from the study findings that have been reported, some other studies (Armania, Eftafiyana, Sugandi, 2018, Fajriyah & Asiskawati, 2015, Fitriani, 2013, Juliati , Firman, Nugraha, 2018) detected the excelence of RME than cordinary teaching on variety of mathematical hard-skills and sot-skills.

As well, a number of studies (Hanifah, Mirna, Mulianty, Fitriani, 2018, Rubaitun, 2018, Saomi, Sumarmo, 2018, Yusniawati, Hendriana, Maya, 2018) by using variety of teaching approaches reported that students obtained MPSA at moderate up to fairly-good grade level. Nonetheless, other studies (Damayanti, Sumarmo, Maya, 2018, Mulyana, & Hendriana, 2015, Qohar, & Sumarmo, 2014, Sumarni & Sumarmo, 2017) by implementing various of inovative teaching approaches reported that students attained at fairly good grade on SRL.

METHOD

This research was a pretest and postest experiment design having a goal to investigate the role of realisitcs mathematics education (RME) on mathematical problem solving ability (MPSA) and self regulated learning (SRL). The subject of this research was 60 seventh grade students of a Yunior High School determined purposively. By using Hendriana & Sumarmo (2014) and Sumarm0 (2019) as references, it were obtained charactristic of MCTA test and SRL scale as attached in Table 1.

Table 1. Characteristics of Instruments of This Study

Test and Scale	n Subyect	n Item & Test Scale	Discrimin at power	Difficulty index	ItemValidity ($t_{table} = 2$	Relia-bility
MPSA test	30	5	.25 - 53	.55 - 58	.85 - .93	.93
SRLScale	30	30	-	-	$1.77 < t < 6.03$	

In the following we attached some sample of instruments of this study.

1. **Sample of MPSA test**

   Dindin bought 9 books and 10 colored pencils for Rp.61,000.00 at the AA Shop. At the same shop Rina bought 10 notebooks and 5 colored pencils for Rp.52,500.00. On other day, Dindin and Rina jointly collected Rp.200,000. They want to know if the money is enough to pay 25 books and two dozen pencils.

   a. Write the known information and the asked information in the situation above.

   b. Compile a mathematical model to calculate the price of each book and each pencil.

      Write down the mathematical concepts contained in the model. Explain and then finish.

   c. Then write down how Dindin and Rina knew the adequacy of their money to buy 25 books and two dozen pencils.

d. When their money is not enough, determine how much money should be added. When their money is excess, calculate how much change they received. Explain how to calculate it.

2. **Sample of some items of SRL statements**

No.	Statements	SA	S	DA	SDA
1.	I learn liniear inequality of one variable tasks caused I love them.				
2.	I waited for teacher's help when I should				
3.	I check the truth of each step of solutions when I completed linear two variable tasks.				
4.	I first try to evaluate the truth of statements of algebraic forms before asking them to a friend				
5.	I avoid setting the target value of the SPtLSV test to be achieved because it is a burden in learning				
6.	I am challenged to check the correctness of the difficult SPtLSV calculation process.				

Note: SA: strongly agree A: agree DA: disagree SDA: strongly disagree

RESULTS AND DISCUSSION

Results

Findings of this research namely student's grades of MPSA and SRL based on teaching approaches were attached in Table 2.

Table 2. Student's MPSA and Its Gain (N-G), and Student's SRL In Both Teaching Approaches

Variables	$\bar{x}$ and s	Realistic mathematics Education (RME)				Scientific Approach (SA)			
		Pretes	Postes	$\langle g \rangle$	n	Pretes	Postes	$\langle g \rangle$	n
MPSA	$\bar{x}$	15.47	32.9	.50	30	13.73	31.47	.49	30
	sd	1.73	2.10	.07		1.65	1.50	.05	
	%	30.94	64.8			27.46	62.94		
SRL	$\bar{x}$		90.53		30		86.80		30
	sd		11.72				12.51		
	%		68.58				65.76		

MPSA: mathematical critical thinking ability Ideal score: 50

SRL : self regulated learning Ideal score: 132

In pre-test there were no different students' grades of MPSA of both class teaching approaches, and the grades were at very low level. But afther teaching approaches, the study found that RME took better role than SA on obtaining students' MPSA, its N-Gain, but those

grades MPSA of students wer at moderate grade level. As well as, there were no different grades of MSRL of students in both teaching approaches and those grades were at moderate-prety good qualification. Testing hypothesis of those means of MCTA and MSRL on both teaching approaches were attached in Table 3.

The finding of this research that students' grades on MPSA which at moderate level was different with finding of Romlah et.all. (2018), but they were similar to the findings of other previous studies that students getting treatment with various innovative teaching students attained MPSA at moderat to fairly good grade level (Fitriani, 2013, Hendriana, Johanto, Sumarmo, 2018, Hidayat, Sabandar, Syaban, 2018, Krisnawati, Rohaeti. Maya, 2018, Maya, & Ruqoyah, 2018, Rubaitun, 2018, Yusniawati, Hendriana, Maya. 2018).

Table 3. Testing Hypotesis of Mean Difference of Mathematical Problem Solving Ability Its N-Gain, and Self Regulated Learning on the Both Teaching Approcahes

Variables	Teaching approach	$\bar{x}$	s	n	Sig.(1tailed)	Interpretation
MPSA	RME	32.9	2.10	30	.00 < .05	$MPSA_{RME} > MPSA_{SA}$
	SA	31.47	1.50	30		
N-Gain of MPSA	RME	.50	.07	30	.069 > .05	No dfferent
	SA	.49	.05	30		N<G> $MPSA_{RME}$ and N<G>$MPSA_{SA}$
SRL	RME	90.53	11.72	30	.195 > .05	No dfferent
	RME	86.80	12.51	30		$MSRL_{RME} > MSRL_{SA}$

The findings of this research reported similar findings on SRL that students getting treatment with variety innovative teaching approaches obtained SRL at fairly good grade level (Damayanti, Sumarmo, Maya, 2018, Mulyana, & Hendriana, 2015, Qohar, & Sumarmo, 2014, Retnaningsih, & Sugandi, 2018, Rohaeti, Budiyanto, Sumarmo, 2014, Romlah, Sumarmo, Syaban, 2018, Sumarmo, Suharyati, Maya, 2018 Sopian, Sabandar, 2018).

Further analysis was about student's difficulties on completing MPSA tasks was attched in Table 4.

Table 4. Mean Score Of Each Item Of MPSA on Both Teaching Approaches

Teaching approach	Stat.Desc	No.1	No 2.	No.3	No.4	No.5
	Ideal score	10	10	10	10	10
RME	$\bar{x}$	6,5	6,9	6,6	6,3	6,6
	% out of IS	65	69	66	63	66
SA	$\bar{x}$	5,97	5,97	7,13	6,2	6,2
	% out of IS	59.70	59.70	71.30	62	62

The study found that almost students in both teaching approaches (RME and SA) attained at moderate grades of MPSA (around of 60% out of 50).

In further analysis, by using statistic Pearson-Chi Square (χ^2) and contigency table the research found that χ^2 = 1,271[a] and sig = .433 > .05 (Table 4). It meant that there was no association between MPSA and SRL

Table 4. Test of Pearson-Chi Square Between MPSA and SRL

Pearson-Chi Square (χ^2)	DF	Sig.(2-tailed)	Sig.(1-tailed)
1,271[a]	4	.866	.433 > .05

Discussion

Relating to students activities during RME lessons, students performed good performance and participated the lessons well, such as they work together to identify the problem actively, they formulate and solve problem enthutiasticsally (Figure 1).

Figure 1. Students were active to answer teachers' question in RME class

Moreover, students tended to be comfortable with implementation of RME. Despite at first time students were confused to learn in new strategy (RME) and to solve new kind mathematics problems, but in next sessions students accustomed to completing tasks in SWS actively. Overall students showed positive opinions on the implementation of RME.

CONCLUSION

Based on findings and discussion, the research derived conclusion as follow. Realistics Mathematics Education (RME) approach took better role than Scientific Approach (SA) on improving students' MPSA, and its gain. However the students' MPSA were at moderate grade level and students' grades on MSRL were at moderate-fairly good level. Most students on both teaching approaches did not encounter difficultiy in solving MCTA tasks. The other conclusion were that, students peformed active learning in all four phases of RME approach, and there was no association between MCTA and SRL

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