EDUCATIONIST

Jurnal kajian filosofi, teori, kualitas, dan manajemen pendidikan

ISSN 1907-8838

Vol. V No. 1/Januari 2011

EDUCATIONIST

Jurnal kajian filosofi, teori, kualitas, dan manajemen pendidikan

Terbit dua kali (Januari dan Juli) dalam satu tahun

Alamat Redaksi
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Tlp./Fax. (022) 2001454
Website : http://educationist.jurnal.upi.edu e-mail : educationist@upi.edu, dr_educ@hotmail.com

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DAFTAR ISI

Improving Students' Mathematical Problem Solving Ability and Disposition by Using Problem Based MHM Strategy

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ABSTRAK

Artikel ini membahas temuan-temuan dari eksperimen dengan perbandingan kelompok statis dengan menggunakan strategi pembelajaran berbasis MHM untuk meneliti kemampuan pemecahan soal matematika dan disposisi matematika siswa. Penelitian ini dilakukan dari bulan Juli hingga November 2009 dan melibatkan 126 siswa dari dua SMP yang berkualitas tinggi dan menengah di Yogyakarta. Instrumen penelitian ini adalah tes Mathematical Prior Ability (MPA), tes MPSA dan skala disposisi matematika. Data dianalisis dengan ANOVA dua jalur dan uji chi-kuadrat. Penelitian membuktikan bahwa di sekolah dengan kategori sedang, para siswa yang mengikuti pembelajaran dengan strategi MHM berbasis pemecahan soal memperoleh MPSA yang lebih baik daripada siswa yang mengikuti pembelajaran konvensional. Di sekolah yang berkategori tinggi, tidak ada perbedaan MPSA dan disposisi matematika siswa. Penelitian ini juga membuktikan bahwa tidak ada asosiasi atau hubungan antara MPSA dan disposisi matematika.

Kata kunci: Strategi MHM berbasis masalah, kemampuan pemecahan soal matematika, disposisi matematika, interaksi, asosiasi.

Some mathematical teaching learning objectives in Indonesia's school curriculum (2006), Kurikulum Tingkat Satuan Pendidikan (KTSP), 2006), and National Educational Standard Board (2006) are to develop students' mathematical problem solving ability and to have positive attitudes toward the usefulness of mathematics in daily life, having curiosity, attention and interest in learning mathematics, and having persistent and self confident in solving problems. NCTM (2003) names e affective goals as mathematical disposition. Branca (Sumarmo, 1994) proposes the importance of having mathematical problem solving ability as follows: 1) mathematical problem solving ability is the goals of teaching and learning mathematics, moreover it is the heart of mathematics, 2) solving problem includes methodology, procedure, and strategy in solving problem are the main processes in mathematics curriculum; and 3) problem solving is a basic ability in learning mathematics.

Concerning problem solving, there is no single formal definition (Jonassen, 2004; Chamberlin, 2008), and some experts (Polya, in Sumarmo, 1994, Gagne, in Kirkley, 2003, nakin, 2003, Jonassen, 2004) propose different definitions of problem solving. Polya (Sumarmo, 1994) defines poblem solving as an effort for seeking solution of a difficult or non-routine problem. According to Gagne (Kirkley, 2003), problem solving is a process to synthesize a vaiety of comcepts, rules or formulas to find solution of a problem. While, Nakin (2003) defines problem solving as a process using a step-by-step heuristic) to find a solution of a particular problem. Whereas, Jonassen (2004), states that when a problem is described as an known entity, so problem solving is defined as a process of discovering the unknown entity.

Previosly, Polya (1973) propose a model, procedure, or problem solving heuristic that consists of four stages, i.e. 1) understanding the problem, 2) designing a plan, 3) implementing the plan, and 4) looking back. Understanding the problem is to identify necessary facts, concepts, or concepts for solving problem. Designing a plan implies to compile a mathematical model of the problem. Implementing a plan refers to solve the mathematical model. Meanwhile, looking back indicates to evaluate the appropriateness of the solution. Similar to Polya, Marshall (1989), states three important aspects in evaluating mathematical problem solving ability. The first aspect is to understand the factual knowledge relevant to the problem solution. It is similar to understanding the problem. The second is to master procedural knowledge. Related to the uses of problem solving strategies or designing a plan and implementing it. And the last is to govern mathematical procedures for determining the solution. According to Schon (Jonassen, 2004), and Maher (Chamberlin, 2009) a key for completing a problem successfully is to represent the problem precisely in a form of mathematical expressions by using mathematical notations or symbols. Such activity is similar to compile a mathematical model similar to a part of designing plan strategy of Polya's procedure.

Sometimes, people perceive that problem solving process has already finished when the solution is found. However, Brownell (MsIntosh, 2000) considers that an individu ia able to finish a problem completely when he understands meaningfully the process of solving the problem and understand the reason of obtaining the solution. I means that reflection ia an important step in problem solving actiivity. To observe the cognitive and affective demands included in the mathematical problem solving activities, it can be concluded that problem solving ability is classified as higher order mathematical thinking that needed a relevant teaching learning strategy and a degree of students' disposition.

In connection with disposition, Polking (1998), proposes some indicators of mathematical disposition: 1) self confident or self efficacy in implementing mathematics, solving problems, giving a reason, and communicating mathematical ideas, 2) flexibility in investigating mathematical ideas and attempting to seek alternative methods in solving problems; 3)persistent in doing mathematical tasks, 4) interest, curiosity, 5) tend to monitor and to reflect their performance and reasoning; 6) to evaluate the application of mathematics in other situation or daily life; 7) taking appreciation on the role of mathematics on culture and value system, and the role of mathematics as a tool and language symbols. Similar to Polking's statements above Standard 10 NCTM (2000) states that mathematical disposition covers: self efficacy, expectation, and metacognition, enthutiastics, and serious attention in learning mathematics, persistent in posing and solving problems, high curiosity, and ability to share ideas with other people. While, Kilpatrick, Swafford and Findell (2001) mentions mathematical disposition as productive disposition that are positive attitude and habits to consider mathematics as logical, useful, and beneficial things. According to Katz (2009), disposition is a tendency to conciously, orderly, and voluntary in a certain behavior that lead to atain specific goals. In mathematical context, mathematical disposition relates to how students perceive and solve problems, self-confident, interested, and flexible thinking to explore various problem solving strategies.

Mathematical problem solving ability and disposition cannot be developed optimaly in a vacuum learning situation, but they need some supporting varièbles such as a context, situation, or social environment. Sumarmo (1993, 1994) found that high school mathematics teaching and learning processes involved less students activities so that students less active in learning and their mathematical problem solving abilities were low. Likewise, some studies (Heningsen and Stein, 1997, Mullis, et al in Suryadi, 2004, Peterson, 1992) reported that many mathematics teaching processes tended to focus on lower mathematical thinking or procedures processes. Meanwhile, TIMMS (Suryadi, 2004) reported that teaching learning process which stress more on reasoning and problem solving activities, such as in japan and Korea, are able to generate students with high performance in mathematics. Mullis, et al (Suryadi, 2004) indicates that non routine problems of TIMMS are failed to be solved correctly by Indonesian students. Howefer, some studies (Ansyari, 2004, Darta, 2003, Hamzah, 2003, Sugandi, 2001, Wardani, 2002) reported that students taught by innovative teching learning strategies and involved students active learning attained higher mathematics abilities than of students learned in conventional teaching. Those findings support an opinion that innovation teaching learning strategy which involves students active learning and poses students to some challenging problems will fasilitate studnets to develop their order mathematical thinking such as problem solving ability and their disposition as well.

Millman and Jacobbe (2008) offer an innovative teaching strategy that is named problem-based Mathematical Habits of Mind (MHM) strategy for developing students' mathematical problem solving ability. The MHM strategy consists of six activities: 1) to explore mathematical ideas, 2) to reflect the appropriateness of the solution, 3) to identify strategies that can be used to solve the broader problem, 4) to ask themselves whether there are "something more" on mathematical activities undertaken (generalization. (5) to formulate a question and 6) to construct an example.

To consider the advantages of the activities of the MHM strategy and positive findings of some studies above, they motivate the researcher to conduct an experiment to investigate the role of MHM strategy on students' mathematical problem solving ability and disposition. Moreover, based on the nature of mathematics as a structured science it is predicted that students' prior knowledge ability and academic school level have important role on improving student's mathematical problem solving ability and disposition as well.

Methods

The purpose of this study is to investigate the roles of problem-based MHM strategy, students' prior mathematics ability, and the academic school level on the students' attainment of mathematical problem solving ability and disposition. The study is a post test experimental static group comparison design (Ruseffendi, 2005) as follow.

X O

O

X is a problem-based MHM strategy
O is a set of mathematical problem solving test and a mathematical disposition scale.

The study was conducted in July – November 2009 and involving 126 Junior High School students from four ninth grade classes selected purposively of two academic school levels (high and medium levels) in Yogyakarta. The experiment was preceded by a set of prior mathematics ability (PMA) concerning the prerequisite topics of the mathematical problem solving test. By using actual criteria comparaed to the ideal PMA score, the students' PMA were classified into three levels, i.e. low, medium, and high.

The instruments of this study are a set of prior mathematics ability, a set of mathematical problem solvig ability (MPSA) test and a set of mathematical disposition scale. The MPSA test consists of five items to measure aspects of understanding, strategies and procedures, and communications. While the disposition scale is compiled in Likert model scale and covers some aspects i.e. self confidence, perseverence, flexibility and openess ineterest and curiosity, and a tendency to monitor the own thinking prosesses and performance. To ilustrate the dept of cognitive demand of the test and the effective aspect of the sacale, some ecamples are presented as follow.

1) An example of the mathematical problem solving item test.
   Budi and Adi walk from home to school. Adi leave home at a minutes past 6 and arrive at school at b minutes past 7. While Budi leave home at b minutes past 6 and arrive at the school at a minutes to 7. Adi and Budi walk to school in 25 minutes and 15 minutes respectively. At what time Budi and Adi sill arrive at the school? Explain your answer.
2) Some examples of the statements of mahematical disposition.
   a) I'm certain that my mathematics grades still low even I try to study hard
   b) I'm inafried to ask my teachers or friends when I pose difficulties in solving mathematical problems.
   c) I believe there are other ways to solve mathematical problems beside strategy taught by teacher
   d) I learn mathematics according to my own initiative
   e) I compare my mathematics score to my own target.

The data are analized by using two-way ANOVA and chi suare test.

Findings and Discussion

The description of students' mathematical problem solving abilities (MPSA) and mathematical dispositions (MD) are presented in Table 1 and Table 2.

Based on data on Table 1 and Table 2, the study found that students' MPSA and students MD as well of MHM strategy class totally are higher than that of conventional strategy class (with *p* value 0,0021 and 0,000 respectively). However, in high academic school level, there is no difference of students' MPSA of MHM strategy and conventional strategy classes. These findings indicate that problem-based MHM strategy is superior to conventional strategy on developing students' MPSA and mathematcial disposition as well, especially in medium academic school level. In other words, these findings support an opinion that students of medium academic school level get more benefits from problem-based MHM strategy in developing MPSA and mathematical disposition.

Table 1: Students' Mathematical Problem Solving Ability (MPSA)
based on MPA levels, Academic School levels, and teaching strategy

MPA Level	Statistical Unit	MHM Strategy			Conventional Strategy		
		High School Level	Medium School Level	Total	High School Level	Medium School Level	Total
High	Number of Students	10	2	12	9		9
	Mean	**54,50**	**34,50**	**51,17**	**53,67**		**53,67**
	Standard Deviation	10,14	6,36	12,18	18,62		18,62
Medium	Number of Students	11	11	22	12	19	31
	Mean	**47,27**	**34,36**	**40.82**	**42,25**	**30,68**	**35,16**
	Standard Deviation	9,737	11,88	12,49	22,76	12,00	17,58
Low	Number of Students	10	19	29	10	13	23
	Mean	**39,00**	**36,00**	**37,03**	**36,60**	**26,23**	**30,74**
	Standard Deviation	18,02	8,27	12,26	22,88	11,99	17,90
Total	Number of Students	31	32	63	31	32	63
	Mean	**46,94**	**35,34**	**41,05**	**43,74**	**28,88**	**36,19**
	Standard Deviation	14,14	9,34	13,207	22,07	12,01	19,07

Note: ideal score of MPSA is 72

Further analysis, based on Table 1 indicates that the higher the students PMA and the higher the academic school level, the higher students MPSA as well either in MHM strategy or in conventional teaching. Findings indicate that the PMA and academic school level performa significant roles on the attainment of students' MPSA. However, it is lso found that students of low MPA of problem-based MHM strategy class obtain higher MPSA than students of medium PMA of conventional learning (36.00 and 30.68 res-pectively). This finding demonstrates that the problem-based MHM strategy performans greater influence compareto the influence of students' PMA on attaining students' MPSA. Nevertheles, on attaining students' MD, students of low PMA obtain more benefit compare to students of medium PMA from the advantages of problem based MHM strategy.

Table 2. Students' Mathematical Disposition (MD) based on MPA levels,
Academic School levels, and teaching Strategy

MPA Level	Statistical Unit	MHM Strategy			Conventional Strategy		
		High School Level	High School Level	High School Level	High School Level	Sekolah Sedang	Total
High	Number of Students	10	2	12	9		9
	Mean	**91,66**	**78,53**	**89,48**	**87,40**		**87,40**
	Standard Deviation	11,80	14,98	12,670	8,74		8,74
Medium	Number of Students	11	11	22	12	19	31
	Mean	**88,71**	**84,97**	**86,84**	**88,14**	**73,35**	**79,08**
	Standard Deviation	10,49	5,02	8,25	5,61	9,02	10,67
Low	Number of Students	10	19	29	10	13	23
	Mean	**90,56**	**86,85**	**88,13**	**87,82**	**70,95**	**78,28**
	Standard Deviation	10,76	10,58	10,61	7,30	8,69	11,67
Total	Number of Students	31	32	63	31	32	63
	Mean	**90,26**	**85,68**	**87,94**	**87,82**	**72,38**	**79,97**
	Standard Deviation	10,71	9,20	10,16	6,93	8,83	11,09

Note: Ideal Score is 120,57

This finding is relevant to the Vigotsky's statemet (1978) that through discussion activities, students can develop their potential abilities and disposition as well. For example, students with high mathematical abilities are able to strengthen their undertanding when they explain their ideas to other friends, and the students of low mathematical ability gain better unders-tanding from the explanation or their friends.

Table 3. Test of interaction between teaching strategy and academic school level on MPSA

Data Sources	JK	dk	RJK	F	Sig
Teaching Strategy	735,025	1	735,025	3,228	0,075
Academic School Level	5511,593	1	5511,593	24,208	0,000
Teaching Strategy* Academic School Level	84,453	1	84,453	0,371	0,544
Total	222036,000	126			

Table 4. test of interaction between teaching strategy and academic school level on MPSA

Data Sources	JK	dk	RJK	F	Sig
Teaching Strategy	1952,533	1	1952,533	24,005	0,000
Academic School Level	3154,488	1	3154,488	38,783	0,000
Teaching Strategy* Academic School Level	930,039	1	930,039	11,434	0,001
Total	904098,995				

Analysis on interaction between teaching stratagey and academic school level in MPSA is presented in Table 3, and interaction between teaching strategy and academic school level on MD is presented in Table 4.

Based on analysis in Table 3 and Table 4, there are interaction between teaching strategy and academic school level on MPSA and on MD as well. Those analysis indicate that the influence of teaching strategy on MPSA and on MD depend on academic school level.

Table 5. Association between MPSA and MD

Mathematical Disposition (MD)	Mathematical Problem Solving Ability (MPSA)			
	High	Medium	Low	Total
Very High	3	0	1	4
High	1	2	3	6
Medium	5	14	10	29
Low	3	6	12	21
Very Low	1	0	2	3
Total	13	22	28	63

The other finding of the study is there is not significant association between MPSA and MD (C is 0.412 and p value is 0.116). This finding indicates high score on that MD doesn't guarantee to attaint high score on MPSA, even medium, or low MPSA. Likewise, low MD doesn't caese low MPSA (see Table 5).

Theoritically, for achieving high MPSA a student should have high mathematical disposition, but the findings of the study do not support the hypotesis. It can be explained by Carr's (Maxwell, 2001) opinion that disposition and ability are two different things. For example, a student performs high mathematical disposition, ehen he is going to solve a non-routine problem but his prior knowledge doesn't satisfy for solving the problem so that he fails to solve the problem.

Conclusion

Based on the study findings and discussion, there are some conclusions as follow. Teaching strategy, academic school level, and prior mathematics abilityplay a role on attaining students' mathematical problem solving ability (MPSA) and mathematical disposition (MD). However, problem based MHM strategy performs the biggest role on attaining students' mathematical prpblem solving ability (MPSA) and mathematical disposition (MD) as well compare to the role of prior mathematics ability (PMA) and academic school level. Meanwhile, there are interaction between teaching strategy and prior mathematics ability (PMA) and between teaching strategy and academic level on MPSA and on mathematical Disposition as well. It is also concluded that there is not association between students' mathematical problem solving ability and mathematical disposition (MD).

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