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Missouri Mathematics Project Model Using Problem Based Learning Approach to Increase Problem-Solving Ability

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Abstract

This study aims to discover learning tools of *Missouri Mathematics Project* (MMP) model using valid, practical and effective *Problem Based Learning* (PBL) Approach in order to increase problem-solving ability. The developed tools are considered valid based on validation analysis of matrix material learning tools. The data of the study is collected through provision test and observation. The test data is processed by learning completeness test and independent sample 2 tests. MMP learning tools development produces practical learning tools supported by lesson plan implementation analysis, teacher's response and students' responses. The results of the study showed as follows: The development of MMP learning tools produces valid learning tools based on professional validation and test trial of problem-solving ability, effective learning tools as it meets 75% classical learning completion, the average of class problem-solving ability using MMP model is better than class with expository, development of learning tools using MMP produces practical learning tools.

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INTRODUCTION

One of the reasons why students are unable to achieve the completeness in learning process is the condition where teachers are still in the assumption that all students have the same ability to acquire and to solve mathematics problems according to Vendiagrys as quoted by Ovan (2017). Based on Rahman's opinion (2008) besides other factors, personal traits of each student determine the success of learning.

The most important abilities should have by students in learning mathematics is the problem-solving ability. In accordance with Suherman (2003), problem-solving is a part of fundamental mathematics curriculum as in the learning process and completion, students are possible to gain experience by applying their knowledge and skills in problem-solving routinely.

Polya (1973) explained the solution in problem-solving contains 4 steps of completion phase, they are understanding the problems, planning the solutions, implementing the plans, and rechecking the previous steps. Anderson (2009) stated that problem-solving is a life skill involves the process of analyzing, interpreting, reasoning, predicting, evaluating, and reflecting. Moreover, Polya (Nur Hamiyah & Muhamad Jauhar, 2014) interpret that the problem solving kown as an effort of finding the resolution of a difficulty in order to achieve a goal. In addition, Aris Shoimin (2014) assumed that the problem solving is a skill which includes ability of quest information, analyzing situation, an identifying problem with the aim of producing alternatives, hence, the decision can be taken to achieve the goals.

In accordance with Kenney's statement (Abdurrahman, 2009) suggested a four-step Mathematical problem solving process, which is understanding problems, planning problem solving, implementing the problem solving, and rechecking previous steps. The problem solving ability is a basic ability in Mathematics students need to have. The weak mastery of concepts and principles by students inflicts their problem solving ability.

By using the right learning model in accordance with psychological condition of students, it can help them to use their time as efficient as possible, so that students can easily understand Mathematics. As it is believed, learning model can increase the effectiveness of learning. This statement is corroborated by previous research of Purnomo, Kartono & Widowati (2015), Adiastuty, Rachmad, & Masrukan (2012) and Ulya, Masrukan & Kartono (2012) who concluded that students' ability in problem-solving using learning model is better than students who use expository in learning process as presented in Table 1.

Table 1. The Differences between MMP Learning Model and Expository Learning

Aspect of difference	MMP learning	Expository learning
Concept development/ Material delivering	Material is delivered by teacher or students by discussion and collaboration between them	The teacher is the main role in delivering the Material
Classroom management	Group learning (Students are divided into several groups)	Classical learning (there is no divided group of students)
Learning source	Textbook, assignment sheet (Controlled exercise, seatwork, and homework)	Textbook use is dominant
Learning interaction	Broader learning interaction. Teacher with students, student with study group, student with student individually, and student with learning sources. (Assignment sheet)	The limited learning interaction. Teacher with students or student with student individually only
Concept implementation/ Exercise	Exercise is given twice in the exercise step	Exercise only be given after concept development. Students are ordered to do by themselves or by peers
Teacher and students' role in learning Process	Students are more active during the learning process (Student centered)	Teacher is more active during the learning process (Teacher centered)

Good & Grows (1979) defined MMP as a program designed to assist teachers in the effectiveness of using exercises in order to improve students competency. MMP model designed to combine both independence and collaboration between groups, it is stated on Jannah, Triyanto & Ekana's explanation (2013). Whereas, based on Faroh, Sukestiyarno & Junaedi (2014) they stated that MMP model is a learning model which can involve the activeness of the students in learning process. As the statements above, it is important to conduct a research using MMP learning model.

According to Marshal (2007) the MMP learning model provides effective ways to streamline students' learning time which reviews the previous material; develops new ideas as the extension of previous Mathematics concepts; provides controlled exercises, independent assignments, and homework, thus students can use their learning time effectively. PBL model can improve students' mathematics problem-solving skills (Sudarman, 2007). PBL is a mathematics learning approach that prioritize problem-solving in its learning process. PBL is both process and curriculum in integrated learning. Through PBL, students are able to learn independenly identifying problems in which the knowledge is needed again to deal with new problem situation Boyle (1999).

As one of the important studies to learn, Mathematics needs to learn either in formal or informal condition (Andriani, 2016). Based on Lestari (2012) Mathmatics is a science of logic of forms, compositions, goals, and concepts which are divided into several logic, systematic, and consistent branches.

The recently problem faced in education world is the weakness of learning process implemented in vocational education. In the learning process, students are less motivated to develop their critical thinking. The process of learning tends to lead students to memorize the information rather than make them understand the information and link it to the everyday life.

Based on the observation results conducted in Sailing Vocational School "AKPELNI" Semarang in Mathematics class with Matrix material, it seemed that the students were less interested in the lesson. This condition can be seen that students were less active during learning process. Most students neglected the individual assignment the teacher gave. They tended to ignore their homework. Based on the information from Mathmatics teachers especially X grades teachers, the study results of students classified as low, less than 65 in Even Semester Examination of academic year 2014/2015 with Minimum Learning Mastery Standard (KKM) 70. The low outcomes of students' learning are caused by their tendency to use more time to play rather than to study.

This is the reason why the research was conducted by using the Learning Model of MMP in X grades of Sailing Vocational School "AKPELNI" Semarang in the interest of solving the recent problem. Hence, the aims of this study as follows: to find out the characteristic of Mathematics learning tools results in matrix material using MMP model and PBL approach; to obtain valid Mathematics learning tools which developed by MMP model using PBL approach in matrix material; to find out the effectiveness of learning using MMP learning tools, and PBL approach in matrix material; as well as to determine the practicality of using Mathematics learning tools developed by MMP model with PBL approach to matrix material.

METHODS

This research is included as a development research which emphazises the development of MMP model learning tools with PBL to increase students' problem-solving ability in Matrix material for X grades. The learning tools developed in this study were: Syllabus, Lesson Plan (RPP), Student Worksheet, Modul, and Problem Solving Ability Test (TKPM).

In this recent research, the development of learning tools refers to learning device development model of Thiagarajan, Semmel and Semmel. Due to the limitness of researchers, those models are modified into 3 stages of design, there are the creation of definition, planning, and development.

The research instrument was validated by the experts before it is used to investigate the developed learning tools. The instrument used in this study covers validator's assessment sheet of syllabus, validator's assessment sheet of lesson plan, validator's assessment sheet of student worksheet, validator's assessment sheet of student modul, validator's assessment sheet of problem-solving ability test, observation sheet of lesson plan implementation within learning management, questionnaire sheet of teacher's response upon learning process, problem solving test instrument.

The data were collected by techniques as follows: the validator's assessment data upon compiled or developed learning tools, Lesson Plan implementation data, students' problem solving ability data, teacher and student's responses data.

The assessment conducted by validator upon learning tools of matrix material includes Syllabus, lesson plan, student modul, student worksheet, and problem solving ability test analyzed based on the average score. The average score of each is calculated by dividing the average number of scores of each tool with the number of aspects assessed on the tools.

To determine the completeness of students' problem solving test of MMP class, proportion test formula: one tail test was used, with the classical completeness criteria is 75% of students' complete learning, meaning $\pi = 74.5$.

Hypothesis:
$H_0 : \pi \leq 74.5\%$
(precentage of students' minimum scores 70 using Mathematics MMP learning model and PBL approach less than equal to 74.5%)
$H_1 : \pi > 74.5\%$
(percentage of students' minimun scores 70 using Mathematics MMP learning model and PBL approach more than 74.5%)

To find out whether there are differences towards students' Mathematics skills between the class of Mathematics MMP learning model using PBL approach and class of expocitory using conventional method, we used two different averages of right side test.

Hypothesis:
$H_0 : \mu_1 \leq \mu_2$
(the average of experimental class' problem solving ability less than or equal to the control class).
$H_1 : \mu_1 > \mu_2$
(the average of experimental class' problem solving ability more than control class).

Practical analysis was conducted as follows: (1) the descriptive analysis of Lesson Plan implementation within learning management, (2) the descriptive analysis of teacher's response towards learning tools and its implementation, (3) the descriptive analysis of student's response towards learning tools and its implementation.

RESULTS AND DISCUSSION

The results of the study showed the MMP learning tools development produces valid learning tools as preesnted in Table 2.

Table 2. Validator's Assessment Results of Learning Tools

Learning tools	Validator's score					Average scores
	I	II	III	IV	V	
Syllabus	4.27	3.77	4.38	4.27	4.44	4.23
RPP	4.20	4.00	4.20	4.10	4.25	4.15
LKS	4.00	4.00	4.20	4.10	4.10	4.08
MS	4.00	4.10	4.20	4.20	4.20	4.14
TKPM	4.00	4.14	4.14	4.28	4.42	4.20
Results	Very good, can be used with revision					

The experts' validation results of learning tools, average Syllabus score 4.23 considered as Good, average Lesson Plan score 4.15 considered as Good, average Student's Modul score 4.14 considered as Good, average Student's Worksheet score 4.08 considered as Good, and average Problem Solving Test score 4.20 considered as Good.

The development of learning tools has gone through the process according to the development tools procedures specified in this study which is modification model of Thiagarajan, Semmel and Semmel. Based on

validation results, learning tools are considered valid with revision. The revision results of this learning tools produces the second draft to be used as test trial learning tools at class as presented in Table 3.

Table 3. The Average Precentage of Student Activity during MMP Learning process

Aspects	Average (%)	Criteria
Students pay attention to the homework discussion, apperception and learning objectives delivered by the teacher	79.92	Good
Students do the exercises given by the teacher	79.42	Good
Students enthusiastically ask questions and dig up information	61.11	Good
Students give responses to the questions the teacher gives	83.34	Very good
Students join in group discussion	76.71	Good
Students do exercises individually	81.26	Very good
Students make a summary	68.32	Good

From the Table 3 above the criteria of student learning activity percentage using MMP learning are considered good and very good.

Based on the problem solving steps by Polya, the ability of student problem solving in Mathematics can be assessed through understanding the problem, planning the solution, taking action of the plan, and rechecking the previous steps. The evaluation results of student problem solving in each step are shown in Table 4.

Table 4. The Achievement Results in Each Step of Problem-Solving Ability

Steps of problem solving ability	Value	Qualification
Understanding problem	70	Good
Planning solution	80	Good
Taking action of the plan	72.5	Good
Rechecking	74.29	Good

By the results of student problem solving ability in Mathematics analysis above, the steps of problem solving are considered good. The achievement of understanding problem step is 70, planning the solution is 80, taking action of the plan is 72.5 and rechecking previous steps is 74.29 as in Table 5.

Based on the problem solving test results, we used proportion test. From the normal default data $\alpha = 0.05$ obtained $Z_{0.45} = 0.360$. It is clear that calculated $Z_{value} > Z_{0.45}$ therefore null hypothesis (H_0) is rejected, which means the percentage of students' minimum scores 70 using Mathematics MMP learning model with PBL approach of matrix material is more than 80%.

Table 5. Recapitulation of Problem-Solving Ability Test Results for Experimental and Control Classes

Class	Average of problem solving ability	Percentage of completeness (%)	
		Complete	Incomplete
MMP	81.33	93.33	6.67
Expocitory	69.03	66.67	33.33

Comparative test is used to compare both the average students' problem solving ability scores of MMP class and Expocitory class. The data was collected through post-test of problem solving ability test of MMP and Expocitory class. Because $t_{value} > t_{table}$ (6.44 > 2.00) therefore H_0 is rejected and H_1 is accepted. In conclusion, the average score of problem solving ability of MMP class is greater than in Expocitory class.

In Figure 1, the example of student work that has not yet brought up the problem solving process.

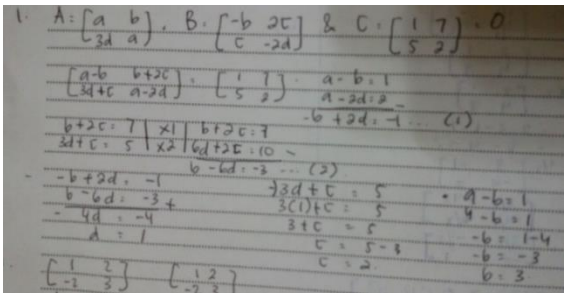

Figure 1. The Example of Exercise Completion That Has Not Yet Brought Up The Problem Solving Process

In Figure 1. It can be seen in the problem solving process, the student is less able to carry out problem solving plan, inaccurate in calculating, and write incomplete structure such as known, answer, and final conclusion in answering the Mathematics problem.

The following Figure 2 shows the student answers after following MMP learning process using PBL.

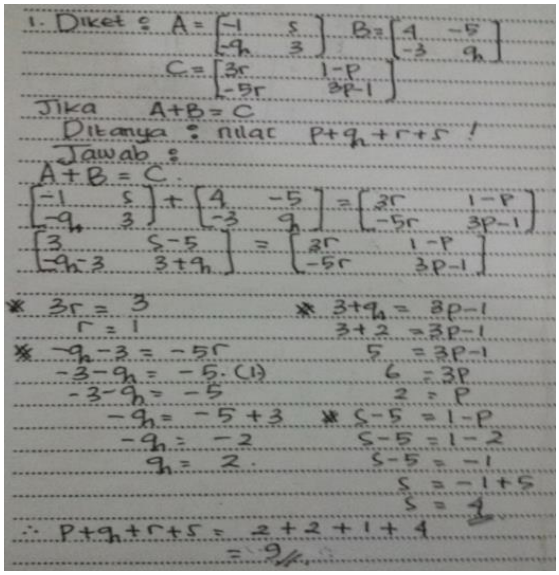

Figure 2. The Example of Student Problem Solving in Answering Mathematics Problem

In Figure 2, students' problem solving ability can be seen at the stage of carrying out a problem solving plan, student is able to carry out a problem solving plan according to the plan, able to do calculations, and write the final conclusion correctly and completely.

The next step is field trial which aims to measure how is the practicality of the use of learning tools. The second draft then be used in neither experimental nor control class. During the test trial, an observation is held in order to discover teacher's competence within managing the class and students' questionnaire towards the lesson. The development of learning tools using MMP model produces practical learning tools, it is proven by the average score of Lesson plan implementation 3.38 known Very good, average score of teacher's response given roundly by role teacher is 3.43 known Very good, and the positive response of students towards the lesson, learning tools and teacher's act is 92%. Based on practical test trial results, it is concluded that using MMP learning model with PBL approach is practical.

After the practical of learning tools, its effectiveness then to be tested in field in order to obtain effective final product. It is considered as effective learning if the obtained results in the experimental class as follows: (a) the MMP class students achieve the completeness of problem solving ability; (b) there is positive impact of learning process skills towards problem solving ability; (c) MMP class problem solving ability is better than expocitory class; and (d) the development of experiment class students' problem solving ability is better than students in control class. The valid MMP model is proven effective as it meets 75% classical learning completion, and the average of MMP class problem solving ability is better than expocitory class as presented in Table 6.

Table 6. Recapitulation of Lesson Plan Implementation Observation Results

Meeting	Score			Criteria
	Observer I	Observer II	Average	
1	3.20	3.27	3.23	Good
2	3.47	3.37	3.42	Very good
3	3.53	3.40	3.47	Very good
4	3.33	3.43	3.38	Very good
Average	3.38	3.36	3.38	Very good

The recapitulation results of both observers using observation sheet of Lesson Plan Implementation. In the first meeting, both observers gave the average score of 3.23 (from maximum score 4) or considered as good. In the second, third and forth meetings, the average scores from both observer are 3.42; 3.42; 3.47; and 3.38; or each of them is considered as very good criteria. The average score of both observers for four meetings is 3.38 or considered as very good.

Most students declare their pleasant feeling towards the lesson, recorded 93.5%. There are many students said that the lesson is a new thing with the average 90.5%. Overall, the number of students who declare their pleasant and new feelings towards the lesson implementation is 92%.

CONCLUSION

This study discovers conclusion that Mathematics MMP model learning tools using PBL approach shows valid criteria in order to increase problem solving ability within matrix material of X grades students. The development of MMP model learning tools using PBL approach to increase students' problem solving ability produces practical learning tools, it is

indicated with: the validation results of developed tools considered as good and implementable, teachers' response considered as very good criteria. Mathematics lesson using MMP model and PBL approach to increase students' problem solving ability of X grades considered as effective learning.

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