THE QUALITY IMPROVEMENT OF MATHEMATICS LEARNING USING PBL MODEL BASED ON WEB

L. Wulandari *), Widowati **), I. Junaedi *)**
***) SMP N 1 Magelang, Indonesia
Email: laila_wulandari@yahoo.co.id
**) Mathematics Department, Diponegoro University
Jl. Prof. H. Soedarto, SH, Semarang, Indonesia
Email: wiwied_mathundip@yahoo.com
*) Mathematics Department, UNNES, Semarang, Indonesia

Abstract

The main objective of this research is to describe the development of the mathematics learning using problem based learning (PBL) for Junior high school olympiad preparation. The approach used in this research is the development of the implementation through Classroom Action Research (CAR). Development of the device uses the development model of 4-D (*Four D model*) from Thiagarajan. In this research is found a learning device using *PBL* model based on web for Junior high school olympiad preparation that it is valid, practical, and effective. The device was developed learning syllabus, lesson plans, teaching materials, students worksheets, and study achievement test. The test device and dissemination limited classes use research subjects 8th grade students of SMP Negeri 1 Magelang, Central-Java, Indonesia. The results of the implementation of the learning development through CAR show that the device is effective , which is characterized by (a) the ability to problem solving, (b) problem-solving ability is affected by the activity of students where problem-solving ability is affected by the students' process skills and problem solving ability test affected both of activity and process skills of students, and (c) the problem solving average ability increases every cycle. The results of the development of this learning can be disseminated more widely.

Keywords: software development, problem based learning, Four-D model, WEB, Effective.

1. INTRODUCTION

Developments in science and technology which is marked by the rapid advancement of civilization and technology of information, have brought new nuances in the joints of the society. Improving the quality of human resources is a major challenge to balance the acceleration. Qualified human resources is a product of a quality education.

Soedjadi (2000) proposed that one of the basic scientific thinking and its application plays an important role in the mastery of science and technology is mathematics. This means that the mastery of mathematics is necessary and important for the whole community, both the application and the patterns of

thought. Therefore, the role of mathematics education is very important in order to develop the human resources of high quality.

The reason for the importance of mathematics to study because so many potential uses, according to Russeffendi (2006): the study of mathematics we are able to count and perform other calculations; math is a requirement for some other subjects; learn math calculations with a more simple and practical , and the learning of mathematics expected us to be a man who thinks logically, critically, diligent, responsible and able to resolve the issue.

The development of science, technology, and art in the end boils down to human resource development. In the implementation process, the mathematics becomes one of the elements needed. As the basic science of mathematics is a means to develop the power of reason to think, how to think logically, systematically and critically. So the role of mathematics is not only felt in the field of mathematics but also in other fields of application.

By combining the usefulness of mathematics and the development of science and technology it is necessary to apply a model of learning mathematics with technology in its application. Thus, in order to develop science, technology, and the arts and to improve students' problem-solving abilities in particular the geometry of the material as well as improving the quality of students' learning needs to be held in preparation for the development of the web based Junior mathematics Olympic through the learning model of *problem-based learning* the students' mastery of competencies. The fact was that encourages writers to develop the learning of mathematics preparation to follow web based junior mathematics olympics the form of *e-learning portal*.

Quality of education in Indonesia ready to face the challenges of the 21st century education that builds community knowledgeable (*knowledge-based society)* with Information and Communication Technology (Thiagarajan, 1978) and media *literacy skills*, Critical thinking skills, problem solving abilities, and the collaborating ability (Uwes, 2008). Achievement required for secondary school mathematics learning process quality, so as to improve and develop the existing learners optimally, the national standard facilities implemented through the educational process with dignity; pro-change; creative; innovative; experimentive;

grow and develop talent; interests, and abilities of learners. These efforts are expected to improve the capacity and average value.

From the description of the background that has been presented, the issues identified are as follows. (1) Not optimal mathematical olympiad coaching due to limited time, costs, and teachers guide. (2) In order to achieve effective learning process required the active participation of teachers and students so that the atmosphere remains conducive and student-oriented learning. (3) The ability of different students encouraged to perform a heterogeneous learning groups that will be established cooperation among its members so as to obtain the maximum learning outcomes. (4) Limited availability of ICT-based math learning resources led to the learning process monotonous and less varied. (5) Websites and e-learning portal School has not been used optimally to support the learning process of mathematics. (6) Olympiad geometry taught in junior high school is a matter that it is difficult for most students. (7) lack of learning tools that are valid, practical, and effective way to help students understanding of olympiad geometry based on web .

Based on the background and the identification of problems that have been described, the aim of the research is to develop the learning models of *PBL* based on web for junior high school mathematics olympiad preparation.

2. RESEARCH METHODOLOGY

There are two approaches used by researchers as follows. (a) Approaches related to the development of learning tools using software development models Thiagarajan. Learning software development procedures used is to modify the model 4-D from Thiagarajan (1974). Researchers develop tools that include: (1) *define*, (2) *design*, (3) develop, and (4) *desseminate*. The device was developed in the form of 1) Syllabus, 2) Learning Implementation Plan (LIP), 3) Students Worksheet (WS), 4) Instructional Materials, and 5) Study Achievement Test (SAT). (b) Related to the implementation approach using action research approach. Researchers use traditional methods of classroom action research to devices used in the study is a device that has been declared invalid and has been tested by researchers using the development model of 4-D from Thiagarajan(1974).

The research instrument developed in this study is the observation of student activity sheets, students' process skills of observation sheet, observation sheets teacher's ability to manage learning, learning pieces of the validation tools and instruments of problem-solving abilities test. The research instrument was developed by modifying the existing research instruments adapted to the learning model used. These instruments were developed after the first validated the experts and well developed at the time of trial. Data on the results of the validation study obtained is used as the basis for revising the learning and research instruments that had been developed.

Analysis of test items were conducted to determine the matter of the achievement test. Analysis of test items referred to in this study is the validity, reliability, and level of difficulty distinguishing features, mastery learning test using *one sample t-test*, Test of proportions using the z test statistics, regression testing, and the influence of an increase in the average test using *N-gain*.

3. RESULTS AND DISCUSSION

The results can be described in two groups, i.e., software development and test results of the effectiveness of learning as follows.

3.1. Results Software Development

Development of the mathematical model of learning *PBL* web based Junior Olympiad preparation set out in two groups, i.e., the validity and practicality of the device.

a. The validity

Results devices developed in this study are 5 types: (1) Syllabus, (2) lesson plans, (3) Teaching Materials, (4) WS and (5) SAT of Problem Solving Ability. The process begins with the development of the initial draft (Draft I). The draft I was further validated by experts (validators) and conducted in accordance with revisions to obtain input validator Draft II. Draft II devices are then tested. During the testing process, the revisions made in accordance with the demands of the field or external inputs in order to obtain the final draft (Draft III).

The results of the study are valid development through defining stages *define*, *design*, and d*evelop* as follows.

a) *Define*

This section described the stages in the development of mathematical teaching instrument in the form of web based PBL model to improve students' problem-solving skills using a modification of the model Thiagarajan (1974) starting from the definition phase to the testing phase.

b) *Design*

The purpose of the design phase is to design the study, in order to obtain *prototype* (learning tools), called by the draft I. Design phase consists of four basic steps, namely test preparation, media selection, format selection and preliminary design.

c) *Develop*

The purpose of the development phase is to produce a draft of the revised learning device based on the experts enter / validator, supervisor and data obtained from the test results. Activities at this stage is the assessment of the experts to the validity of the study.

Validation experts conducted to see the validity of the content of the draft I. The validator that performs validation consists of 5 people who are competent in mathematics research and education. The revisions of the learning device made based on the suggestion of to the Draft validators, so that we find draft II. Furthermore, draft II was tested in the Olympiad class (8^{th}-grade) of SMPN 1 Magelang. The results of the validation of an expert on learning is presented in Table 3.1.

Table 3.1. Results Validation Tool Learning Syllabus, LIP, IM, WS, and SAT

No	Devices	Validator					Average	Category
		I	II	III	IV	V		
1	Syllabus	4.20	4.25	4.10	4.50	4.55	4.32	Very Good
2	LIP	4.33	4.38	4.27	4.44	4.50	4.38	Very Good
3	Instructional Materials(IM)	4.35	4.41	4.29	4.53	4.65	4.45	Very Good
4	WS	4.12	4.23	4.29	4.17	4.35	4.23	Very Good
5	SAT	V / DR	V / TR	V / TR	V / TR	V / TR	-	-

After validation of the contents of the SAT by validator, further tests on Draft II SAT. The experiment is to analyze the problems with the test item validity, reliability, level of difficulty, and distinguishing features.

In general, the results of developed learning instrument by the validation experts are as follows. (1) The syllabus has good criteria and can be used with little revision, (2) Learning Implementation Plan (LIP) have good criteria and can be used with little revision, (3) teaching material students have good criteria and can be used with little revision; (4) Worksheet Students have good criteria and can be used with little revision, (5) problem-solving abilities SAT have good criteria and can be used with little revision.

b. Practicality Devices

The device is said as practical learning in this study if the learning process based learning tools are developed according to the observations of both teachers' ability to manage learning and student responses classified as positive. Observations by teacher observation indicators with a high score of which is to engage apperception (4.688), motivate students / foster curiosity (4.25), conditioned students to resolve issues / problems on their own first (4.375), encouraging students to ask / found in the discussion group (4.313), master class / leading discussions in class (4.563), time management (4.438), and questioning techniques (4.563).

Based on the observations of teachers' ability to manage the learning gained by the average observer ratings of 88.0625 (the highest score of 105) with either category. The response of students to the web based mathematics learning models *PBL* acquired 90.29% of the students expressed pleasure responses (positive).

3.2. Learning Effectiveness Test

Tests carried out in the dissemination of the effectiveness of learning limited class meetings in 3 cycles. During the limited dissemination of data collection included the observation made active student learning and observation skills. At the end of the learning undertaken SAT to measure students' problem-solving abilities.

Data obtained from the limited dissemination analyzed and the results used to determine the effectiveness of learning. Learning effectiveness is measured by three test statistics, namely (a) test students' problem-solving skills mastery, (b) test the effect, and (c) an increase of the class average test. The results of the three statistical tests can be seen in the following explanation.

a) Problem Solving Ability Test

In this study, mastery tests measure problem-solving ability is a mastery test class average. Tests performed using the classical completeness test two proportions. The hypothesis tested is as follows.

H0: π =80% (the proportion of students who achieve Minimum Pass Criteria(MPC) = 80%)

H_1 : $\pi \neq$ 80% (the proportion of students who achieve MPC $\neq$ 80%)

The results obtained are as follows.

i. The number of the students who pass the MPC by 80 is 17 people

ii. The number of students is 20 people.

iii. The value of the hypothesized proportion of 80%.

Z_{count} values obtained as follows.

$$z = \frac{\frac{x}{n} - \pi_o}{\sqrt{\frac{\pi_o(1-\pi_o)}{n}}}$$

$$= \frac{\frac{17}{20} - 0.80}{\sqrt{\frac{0.80(1-0.80)}{20}}}$$

$$= 0.559$$

Using a significance level of 5% Z values obtained $Z_{\frac{1}{2}(1-\alpha)}$ is 1.96. Ho accepted if - $Z_{\frac{1}{2}(1-\alpha)} < Z_{count} < Z_{\frac{1}{2}(1-\alpha)}$. Because the value Zcount = 0.559 then Ho is accepted, meaning that the proportion of students who achieve MPC equal to 80%.

The average mastery test classes are conducted on the data values using the SAT test one side flat.

The hypothesis tested is as follows.

Ho: $\mu \leq 80$ (the average problem solving ability less or equal to 80)

H1: $\mu > 80$ (the average problem solving ability greather than 80)

Results obtained from the test class is as follows.

- average grade ($\bar{x}$) = 83.75
- average value of the hypothetical / MPC (μ_o) = 80
- sample standard deviation (s) = 5.12
- number of samples (n) = 20

t_{count} obtained as follows.

$$t = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}}$$

$$= \frac{83.75 - 80}{\frac{5.12}{\sqrt{20}}}$$

$$= 3.277$$

Using a significance level of 5% and df = (20-1) = 19, values obtained t (1 - α) is 1.73. Obtainable t_{count} = 3.277 > 1.73 then the Ho is rejected, meaning that the average classroom problem solving ability test device is greater than 80.

b) Test of Influence

Based on the analysis of the influence of active students in learning with web based *PBL* has positive influence on the ability of solving problem student. We find that the value ***R Square*** (determination coefficient) is 0.73, it means that the activity affects the problem-solving abilities by 73%, so the remaining 27% are influenced by other factors. This suggests that the higher activity of students, the higher problem-solving ability of students that will be accomplished. This trend is caused by constructivism active student learning relating to the activity and process skills that focus on the pursuit of knowledge or understanding to satisfy curiosity. The role of teachers as facilitators to help students if needed. This means that learning has been implemented on Vygotsky's theory of learning caffolding the effort to find their own ways to solve problems that allow students to grow independently.

The results of the influence analysis demonstrate that the process skills give the positive influence to the problem-solving abilities of students. We find that the value *R Square* (determination coefficient) is 0.714 = 71.4%. it means that the students' skills affect the ability of solving problem amounted to 71.4% and 28.6% influenced by other factors. This shows that the higher the students 'process skills, the higher the students' problem-solving skills will he accomplished.

This is in line with research conducted by Widyatiningtyas (2010) which states that when students perform the skills that will be developed once the desired attitudes as creative, cooperative, responsible, and disciplined in accordance with the emphasis on the field of study concerned. Thus, process skills is a learning process that leads to the development of mental abilities, physical, and social development as fundamental as the higher capacity drive within the individual student. Due to an increase in students' process skills is important to also always strived to be an increase in student achievement can be achieved optimally.

Results influences together Motivation and Skills students to problem-solving ability showed that active and positive influence on process skills problem solving skills together. The magnitude of the effect was 81.7%. This is in line with research Darodjatun (2010) which states that the activities and skills of the students during the learning process influence on academic achievement.

The positive influence occurs because when the activity students physically, mentally, and socially appears it will be also developed physical abilities, mental, and social development so that they will improve their academic achievement. So the activity and process skills are the two interrelated and mutually reinforcing to obtain optimal learning achievement. So the higher activity and the skills of the students problem solving skills have also increased.

c) N-gain Test

The ability of students before being given treatment is reflected in the results of the pretest, and the ability of students treated after being reflected from the posttest. While improving the ability of students is the difference or accretion (gain) between pre-test and post-test scores are expressed in normalized gain scores (N-Gain). To obtain an overview of the capabilities of students before and after given treatment study, the following table descriptive statistics presented pretest scores, posttest, and N-Gain.

Table 3.2. Descriptive Statistics Problem Solving Ability Score

Test	Class Actions					Max. ideal Score
	N	x_{min}	x_{max}	$\bar{x}$	n	
Pre-test	20	55	80	69.00	20	60
Post-test	20	75	93	83.58	20	60
N-Gain	20	0.44	0.65	0.470	20	1

Table 3.2 presents descriptive statistics values pretest, posttest and N-Gain on aspects of problem solving ability. Statistics stated initial ability, the ability to finish and increase the ability of students in aspects of problem-solving skills include the lowest score, highest score, the mean (average) and standard deviation. Pretest and posttest values problem-solving abilities are expressed in scale 0-100 while scoring N-Gain expressed in a scale 0-1.

Based on the descriptive statistics above, when viewed from the highest score, lowest score, and the average (mean) all indicate that there are differences in ability among students both in the pretest, posttest, and N-Gain. The results indicate the ability of solving an average increase in each cycle and the differences in the ability of the pre-test, post-test, and *N-gain* means there is an average increase significantly.

4. CONCLUDING REMARK

Based on the process of development that has been proposed we obtained: (1) learning tools have been developed through a process of validation and otherwise comply with the content validity and construct validity were established

by people who are experts in their fields, the learning tools developed in this research is valid, (2) the mathematics learning of *PBL* model based on web for Junior high school olympiad preparation on the geometry 8^{th}-grade produced practical devices, (3) mathematics learning using *PBL* model based on web is effective.

The results of the development of this device is valid, practical, and effective. Hence learning device have been developed in this research need to be disseminated to the class and other schools that have similar characteristics to obtain better learning and the device learning should be updated so there is always a refresher from time to time.

REFERENCES

Darodjatun, G., 2010, *Development of the Student Learning Mathematics constructivism Based Active Learning Approach Problem Posing With Interactive CD Aided Material Geometry Class VIII*.Thesis. Semarang: Unnes.

Ruseffendi, 2006(1988?), *Fundamentals of Modern Mathematics and Computers for Teachers. Bandung*: Tarsito.

Soedjadi, R, 2000, *Tips for Mathematics Education in Indonesia.* Director General of Higher Education. Jakarta Department of Education.

Thiagarajan, S., 1978, Instructional Product Verification and Revision: 200 Questions and Speculations. *Educational Communication and Technology (An Analysis of Research Needs in Educational Communication and Technology*), 26 (2) Part 2: 133-141. New York: Springer.

Thiagarajan, S., D. S. Semmel, and M. I. Semmel, 1974, *Instructional Development for Training Teachers of Exceptional Children, A Source Book*. Blomington: Indiana University.

Uwes A. C. , 2008, *Encourage Implementation of E-Learning in Schools.* Papers Presented in National Seminar on "The Power of ICT in education". Yogyakarta: Graduate Program.

Widyatiningtyas, R. , 2010, Role of Teacher in Doing Skills Assessment Process *Educare: Journal of Education and Culture.*