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Increased mathematical literacy and HOTs through realistic learning assisted by e-schoolology

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Abstract. This study aims to determine the development of realistic learning tools (RME) assisted by e-schoolology that are valid, practical and know the effectiveness of such learning to improve mathematical literacy and improve higher order thinking skills (HOTs). The population of this research is students of SMPN 9 Semarang. The sample is taken randomly and gets 1 class. The class is given a preliminary test of mathematical literacy and HOTs, then realistic learning is assisted by e-schoolology and afterwards a final test is given. The results showed that realistic e-schoolology learning developed is valid, practical and there were differences in mathematics literacy skills and HOTs after learning compared to before. Because the mean literacy abilities of mathematics and HOTs after learning are higher than before learning, it can be concluded that realistic learning assisted by e-schoolology can increase mathematical literacy and HOTs.

1. Introduction

Mathematical learning innovation is done by selecting learning methods that are appropriate to the material and characteristics of students and can build student character so that it can increase student motivation in learning mathematics. One of the mathematics learning that can have a positive impact on the ability of PISA-based mathematics literacy students in problem solving and can build student character is the Learning of Indonesian Realistic Mathematics Education (PMRI), hereinafter referred to as realistic learning with e-learning schoolology, then written with realistic e-learning schoolology. One of the advantages of realistic learning (PMRI) as stated by Wijaya [1] is emphasizing learning by doing, in accordance with the basic concepts of realistic mathematics learning expressed by Freudental [2] namely "... mathematics as a human activity ... ". Students are not directly served with abstract mathematical concepts, but are delivered first through real learning that is transformed into abstract concepts. In realistic mathematics learning, students are given the opportunity to rediscover ideas or mathematical concepts with an activity carried out by students under the guidance of the teacher. The principle of rediscovery (guided reinvention) can be started from informal problem solving procedures, while the process of reinvention uses the concept of mathematical / formal mathematics. Schoolology is a very promising educational media in meeting current and future challenges, especially the 21st century teaching problem [3]. Schoolology is a website that integrates e-learning and social networking [4]. This social web offers learning as in the classroom and is easy to use [5]. According to Amiroh in Efendi Agus [6] mentioned several advantages of schoolology, including: a) Schoolology provides more choices of resources than that provided by Edmodo. b) Schoolology can accommodate the type of questions (question bank) that will be used during the quiz. c) Schoolology provides attendance attendance facilities that are used to check student attendance. d) Schoolology also provides



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analytical facilities to see all student activities on each course, assignments, discussions and other activities prepared for students.

Schoology helps teachers open broad communication opportunities for students to take part in discussions and teamwork. Besides that Schoology is also supported by various forms of media such as video, audio and images that can attract students' interests. Schoology directs students to apply the use of technology in learning.

PISA-based LM refers to philosophy, mathematics is not an isolated science from human life, but mathematics emerges from and is useful for everyday life [1]. PISA is a study of international student assessment programs organized by the Organization for Economic Cooperation and Development (OECD). PISA [7] aims to assess the extent to which students who sit at the end of a basic education year (students aged 15 years) have mastered the knowledge and skills necessary to be able to participate as citizens or members of the community. Mathematical literacy itself is interpreted [8,9] as a person's ability to formulate, apply, and interpret mathematics in a variety of contexts, including the ability to do mathematical reasoning and use concepts, procedures, and facts to describe, explain or predict phenomena / events. The understanding of PISA-based mathematics literacy is in line with the Content Standards (SI) of mathematics subjects. PISA-based LM results in 2009 [10-12] and in 2012 Indonesian students' mathematical literacy scores were still very low because they were ranked 64 out of 65 countries, the latest results in 2015 ranked 63 out of 70 countries.

Higher Order Thinking Skills (HOTS) was originally known from the concept of Benjamin S. Bloom et al., in a book called *Taxonomy of Educational Objectives: The Classification of Educational Goals* [13] which categorizes various levels of thought called Bloom's Taxonomy, from the lowest to the highest. This concept is a learning goal that is divided into three domains, namely Cognitive (mental skills around knowledge), Affective (emotional side around attitudes and feelings), and Psychomotor (physical abilities such as skills). The concept of taxonomy to determine learning objectives can be called the ultimate goal of a learning process. So, after a certain learning process, students are expected to adopt new skills, knowledge and attitudes. HOTS itself is part of the cognitive realm that exists in Bloom's Taxonomy and aims to hone mental skills around knowledge. Bloom's cognitive domain was later revised by Lorin Anderson, David Karthwohl et al. in 2001 [14]. The order was changed to six, namely: (1) Remembering, (2) Understanding, (3) Applying, (4) Analyzing, (5) Evaluating, (6) Creating. Levels 1 to 3 are categorized as low level thinking ability (LOTS), while levels 4 to 6 are categorized as high level thinking ability (HOTS). According to the Director General of Learning and Student Affairs Kemenristekdikti, Prof. Intan Ahmad, Ph.D., HOTS is a way to test whether a student can analyze, compare, calculate, and so on. "So it takes unusual abilities. It's not just memorizing or memorizing." An example of a standard HOTS question which usually contains sentences or tables. Like the question of "Why do mosquitoes fly straight, turn, or survive in the air? Then, why do birds that can also fly have higher speeds?" To answer the HOTS problem, it is not just about answering questions by memorizing formulas, but it is necessary to understand the concepts of the material as well. This HOTS model encourages prospective students to do high-level reasoning so that it is not fixated on only one pattern of answers that results from the memorization process, without knowing the concept of knowledge. HOTS is one of the skills demands in 21st century learning, namely critical thinking, creative, collaborative, and communicative. When arranging HOTS questions, it is possible to create the same type of questions, but with different questions. The giving of HOTS questions to students aims to form quality students who are sensitive to the development of information technology in the digital age. By familiarizing themselves with students solving challenging questions, students' self-potential can also be encouraged to further develop.

Our students must be encouraged and developed high order thinking skills, not just memorizing lessons and knowledge, but being able to analyze, synthesize, and create, "he said. If students are familiarized with challenging questions, their potential can be encouraged to develop. "The introduction of HOTS in the classroom is like giving fertilizer so the seeds of potential for critical thinking, creative growth well". Based on the explanation above, then for the assessment of learning outcomes in the form of mathematical literacy ability in the development of Innovative Realistic

learning using e-learning Schoology media in this study will use the LM PISA question instrument or its modification. PISA-based LM problems in learning are expected to improve mathematical literacy skills and HOTS, which in turn can improve Indonesian mathematical literacy scores in the future PISA test in the future whose results reflect how high the results of young Human Development (ages 13-14 years) and the level of competitiveness of the Indonesian people in the eyes of the world.

The 2013 curriculum requires all subjects to be integrated with information and communication technology (ICT). DeWitte, K., Haelermans, C. & Rogge, N. [15] state that the use of ICT can improve educational outcomes and can replace traditional teaching methods. Indirectly provide space for the creation of an online-based teaching system (internet). Teachers are required to utilize computer and internet facilities as supporting media in the learning process. The development of internet technology gave rise to various new applications as a learning tool. Technology in the field of learning is known as e-learning. Aminoto and Pathoni [4] stated that e-learning that began to be used in schools was generally limited to the delivery of assignments and the provision of materials. E-mail as an account is used in sending assignments to teachers, while the website as a facility in publishing teaching materials. Students are limited to sending assignments and do not know the follow-up on their assignments. In addition, materials available on websites are often only downloaded. Communication between students and teachers is only limited to the teaching and learning process that takes place in the classroom. The application of e-learning will be far more practical and efficient in its use by using LMS (Learning Management System). According to Indrayasa, Agung and Mahadewi [16] one of the LMS that is often used in interactive learning is schoology. Schoology is a web page in the form of a social web where schoology offers learning just like in the classroom and is easy to use like Facebook. In addition, in schoology there are features that make it easier to manage learning and its results, such as making assignments, quizzes, monitoring student activities, as well as various facilities to support social activities and collaboration. Schoology can help teachers to deepen the learning process with students outside the classroom (outside class hours), opening broad communication opportunities to students so students can more easily take part in discussions.

Based on the background of the problems above in this study raised the problem; (1) How to design realistic and valid learning; (2) What is the effectiveness of realistic e-schoology learning to improve mathematical literacy skills and HOTS?

2. Method

This research is an experimental research design pretest treatment posttest. The population is students of SMPN 9 Semarang. Samples were taken at random 1 class. The first step students are given an initial test of mathematical literacy and HOTS. Then the students in the class 1 learned with realistic e-schoology learning and then were given a post-test. The data obtained were analyzed and directed to answer the question whether the learning tools developed have met the criteria of validity, practicality and effectiveness or not. The validity of the learning tools is based on the validity assessment by experts and practitioners who are competent in their fields, while the effectiveness and practicality of the learning tools are based on testing the learning tools in the field (in class). Data analysis techniques used in this study are as follows.

2.1. Data analysis of the learning device validation results

The validator's evaluation of the circle material learning kit includes: (1) Syllabus, (2) RPP (Learning Implementation Plan), (3) Student Worksheet (Student Worksheet), and (5) TKLM (Mathematical Literacy Ability Test) and HOTS. The assessment is based on the rubric of each indicator the researcher made. The assessment data listed on the validation sheet is the rating of each validator for the learning kit, analyzed based on the average score. Average scores from each Syllabus, RPP, LKS, and PISA based KLM and HOTS tests are calculated by means of the average number of scores of each device divided by the many aspects assessed on the device. TKLM devices must be tested first. TKLM is good if it is valid in content, each test item is valid, each test item has a significantly different power, reliable and normal difficulty level.

2.2. Analysis of practicality data

The practicality data analysis used is as follows.

2.2.1. *Analysis of student response data to learning.* Student response data obtained from questionnaires/questionnaires were analyzed by determining the number of respondents who gave positive and negative responses to the categories that were asked in the questionnaire. A positive response means students or teachers support, feel happy, are interested in the learning component. Negative responses mean the opposite. The percentage of each positive response is calculated by the number of positive responses per aspect that appears divided by the number of all students multiplied by 100%.

2.2.2. *Analysis of teacher responses to learning devices.* Data on the results of the teacher questionnaire responses to the learning kit were analyzed using the questionnaire assessment criteria for teacher responses consisting of 5 scores. When conducting and providing an assessment on the teacher's questionnaire response sheet used the assessment guidelines (rubrics) that have been prepared previously by the researcher. The average teacher response is calculated by summing the average teacher response score for each aspect divided by the number of aspects.

2.2.3. *Analysis of the teacher's ability to manage learning.* To find out the level of ability of teachers to manage learning, there must be an observation of the ability of teachers to manage learning in class. Observations were made during the learning process by 2 observers who were from peers. Scoring the ability of teachers to manage learning is applied to a scale of five that has been provided by researchers. Data from observations were then analyzed and averaged

2.2.4. *Data Analysis of the Effectiveness of Learning Tools and Learning Models of Realistic Scientific e-Schoolology with PISA-based Assessment.* Analysis of the effectiveness of learning tools and learning models include Normality Test, Homogeneity Test, PISA-based Mathematics Literacy Completion Test and Mean Comparison Test between the mean mathematical literacy abilities before learning Realistic Scientific e-Schoolology of PISA Pendikar and after learning.

3. Results and Discussion

3.1. The results of a valid and practical learning design study

Learning tools that have been made in the form of syllabus, teaching materials, lesson plans are validated by the validator and tried in another class. After analyzing it turns out that realistic e-schoolology learning tools are valid and practical, this happens because the preparation of learning tools already uses existing Standard Operating Procedures (POS). This happens because the preparation of learning tools namely syllabus, teaching materials, learning implementation plans have referred to realistic learning indicators by taking into account the optimal use of e-learning schoolology media.

3.2. Results of research on the effectiveness of realistic e-schoolology learning

3.2.1. *Research Results in class IX SMP Negeri 9 Semarang.* Based on the calculations shown in table 1, table 2 and table 3 because sig (2 tailed) $0,000 < 0,05$, there is a difference between the mean learning outcomes of Mathematics in Mathematics Literacy and HOTs between pretest and posttest. Because the post test score is $80.66 >$ pretest value 66.06 , the innovative learning of realistic scientific blended learning schoolology with independence characters can improve mathematical literacy and HOTs. Realistic e-schoolology learning effectively improves mathematical literacy skills and HOTs. This happens because with realistic e-schoolology learning, students always learn to solve contextual problems in everyday life with unlimited space and time (with e-schoolology) so that they contribute to

the components of mathematical literacy and HOTS so that they can improve it. This is consistent with the results of the study Maulana, Wardono, Marwoto & Mariani [17], realistic learning assistance schoology can improve mathematical literacy skills in junior high school students. Wardono & Mariani [18] have researched that RME / PMRI is a learning approach that encourages every student in the mathematics class to do mathematical contests in using mathematics to solve everyday problems or mathematical problems they face. This can improve the mathematization student which is an important component of mathematical literacy so that it can automatically improve students' mathematical literacy. This is also consistent with the results of research from Wardono & Mariani [19] and Wardono et.al [20] that the use contextual problems (in realistic learning) offers some potentials to engage and motivate students in learning mathematics but it also presents some challenges for students in classrooms. So from the results of the implementation of learning tools and realistic innovative learning models a scientific blended learning e-schoology approach containing character building at SMP N 9 Semarang can effectively improve mathematical literacy and HOTS based on PISA.

Table 1. Paired Samples Statistics

| | | Mean | N | Std. Deviation | Std. Error Mean |
|--------|--------------------|---------|----|----------------|-----------------|
| Pair 1 | HBM_Pretes_9A_SMP9 | 66.0625 | 32 | 7.30416 | 1.29121 |
| | HBM_Postes_9A_SMP9 | 80.6562 | 32 | 7.31154 | 1.29251 |

Table 2. Paired Samples Correlations

| | | N | Correlation | Sig. |
|--------|---|----|-------------|------|
| Pair 1 | HBM_Pretes_9A_SMP9 & HBM_Postes_9A_SMP9 | 32 | .325 | .069 |

Table 3. Paired Samples Test

| | | Paired Differences | | | | T | df | Sig. (2-tailed) |
|--------|---|--------------------|----------------|-----------------|--|--------|----|-----------------|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference Lower Upper | | | |
| Pair 1 | HBM_Pretes_9A_SMP9 - HBM_Postes_9A_SMP9 | -1.45938E1 | 8.48855 | 1.50058 | -17.65420 -11.53330 | -9.725 | 31 | .000 |

4. Conclusions

Conclusions that can be drawn namely; (1) A realistic e-school learning tool that has been developed with the correct procedures so that a valid and practical learning tool is obtained. (2) Realistic e-schoology learning tools developed effectively can improve mathematical literacy skills and HOTS

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